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THE
LARYNGOSCOPE.

VOL. LXI JULY, 1951. No. 7

THE RESPIRATORY FUNCTION OF THE LARYNX.*†

III — THE RELATION OF FIBRE SIZE TO FUNCTION IN THE RECURRENT LARYNGEAL NERVE.

JOHN A. MURTAGH, M.D., and
CLARENCE J. CAMPBELL, M.D. (by invitation),
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In a previous report[1] on the basis of measurements of chronaxie and observations on the activity of the glottis, we expressed the opinion that "the greater number of fibres in the recurrent laryngeal nerve are relatively large and supply adductor muscles," and again that "there are some few fibres supplying the abductor muscle which must be smaller and probably less heavily medullated. Presumably these would be more readily injured by chemical or mechanical agents." With this in mind we have since examined histologically a number of "normal" recurrent laryngeal nerves in man and in the animal. The human nerves were obtained postmortem. We have also examined, when obtainable, involved recurrent nerves removed at autopsy in individuals who have presented the clinical picture of recurrent laryngeal abductor palsy and have attemped to evaluate the fibre population in the normal nerve and the existing variations from the normal in the paralyzed recurrent nerve.

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METHOD.

The nerves were first placed in osmic acid solution (Department of Pathology, Hitchcock Hospital). This fixed and stained the myelin sheaths, and on these blackened sheaths all the measurements were made. When satisfactory sections were obtained, they were photographed. Enlargements were made and printed on bromide paper. The magnification was 720 diameters. Measurements were made of these prints by matching as nearly as possible the diameters of any particular fibre with one of a series of circles of given diameter etched on a plastic scale. None of the fibres was perfectly circular, so that an exact match was never possible. In consideration of this, a transparent scale was prepared with circles of diameters of 2, 4, 6, 8, 10 and 12 mm. The fibres were placed in one of six categories: 0 to 2, 2 to 4, 4 to 6, 6 to 8, 8 to 10 and 10 to 12 mm. Each millimeter on the enlarged photograph is equivalent to 1.39 micra. The analysis, however, is based on the measured diameters (in millimeters), remembering always that at no time was any attempt made to accurately measure any one fibre. All fibres are merely reported as falling within the limits of each category. The analysis is based on percentage of the whole in each group.

The procedure may be best understood by referring to Table I (R. L. N. 128 involved), which is the count on a nerve of a patient who died of carcinoma of the esophagus and who presented the clinical picture of recurrent laryngeal abductor palsy. The categories into which the fibres fall are reported as diameters 2, 4, 6, etc. In the vertical column on the left is the list of individual bundles which make up the nerve. The actual counts are recorded and totaled across to give the number of fibres in individual bundles and vertically to give the number of fibres in all bundles which fall into a particular category. The percentage representation of each category in the entire nerve is calculated and appears in the bottom horizontal row of Table I.

RESULTS.

As work progressed, it became more apparent that the recurrent laryngeal nerve is not a single fibre bundle as might

TABLE 1.

R.L.N. 128 Left Involved I							
DIAMETERS	2	4	6	8	10	12	TOTAL
AB_{10A}	5	3	13	51	4	0	76
AB_{10B}	48	226	174	52	5	0	505
AB_{11A}	0	5	14	29	35	8	91
AB_{11B}	7	34	49	56	3	0	149
AB_{11C}	0	16	73	38	44	0	171
AB_{12A}	17	40	25	6	0	0	88
AB_{12B}	3	4	13	0	0	1	21
AB_{12C}	2	59	45	37	16	5	164
AB_{13A}	103	204	163	85	10	1	566
AB_{13B}	47	136	107	50	3	0	343
AB_{13C}	77	216	136	52	10	0	491
TOTAL	309	943	812	456	130	15	2665
	11.6%	35.4%	30.5%	17.1%	4.9%	.56%	100.06%

be suggested by Fig. 5 of a previous paper.[1] There are invariably several 4 to 6, and frequently as many as 12 bundles of nerve fibres which appear to make up the whole nerve (see Fig. 1). The actual number of fibres in a single nerve will depend on the level at which the section is made. There are invariably more fibres peripherally than centrally as long as sections include the entire nerve (Eccles cited by Fulton).[2]

The actual percentage counts of various nerves that we have examined may be seen in Figs. 2 through 7. In Figs. 2, 3 and 4 are shown counts completed in "normal" human nerves. The striking similarity of nerves 1, 3 and 4 is brought out in Fig. 3. Human nerve No. 2 has more fibres in group 0 to 2 mm. than any of the other nerves examined. A possible explanation of this appears in Fig. 4 where the same nerve has been sectioned and counted at two levels. The central end of this nerve (A-50-26) shows some 33 per cent in category 0 to 2 mm., which compares reasonably well with count 0 to 2 in nerves 1, 3 and 4. In the peripheral end of human nerve A-50-26 there are some 1,500 more fibres in the total count than the central end of the same nerve, and the category 0 to 2

shows 48 per cent, which may be compared with 52 per cent in the same category in human No. 2. There exists, then, the possibility that the section of human nerve No. 2 may have been taken more peripherally than that of nerves Nos. 1, 3 and 4. The count in No. 2 is approximately 1,000 greater than that shown in No. 1, 3 or 4. This might be a further indication that this section was made more peripherally. It is also obvious that the counts in the first four human nerves is definitely smaller than counts in nerve A-50-26, which were

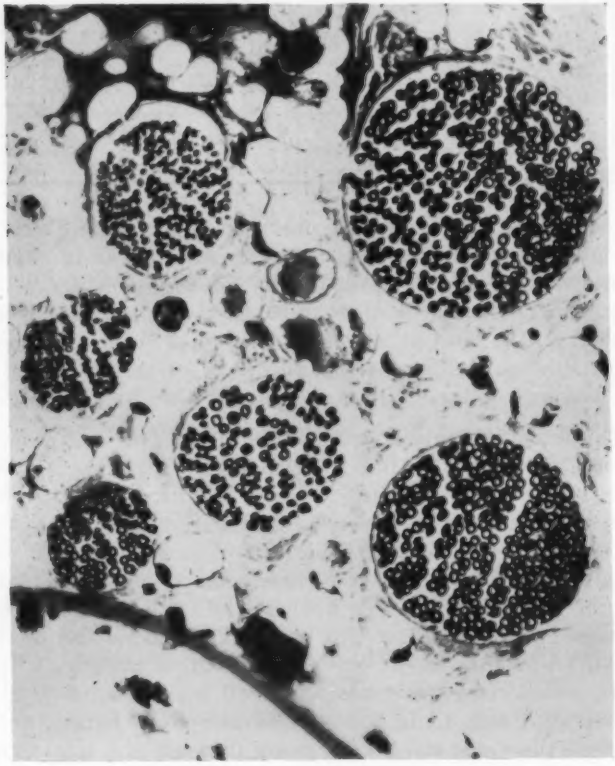

Fig. 1.

done at a later date. Every effort was made to include the entire nerve in all cases. Poor technique may be responsible for the low total counts shown or there may be a wide variation in the actual number of fibres. The histograms, based on percentage of total, show very similar distributions of fibre size in all nerves.

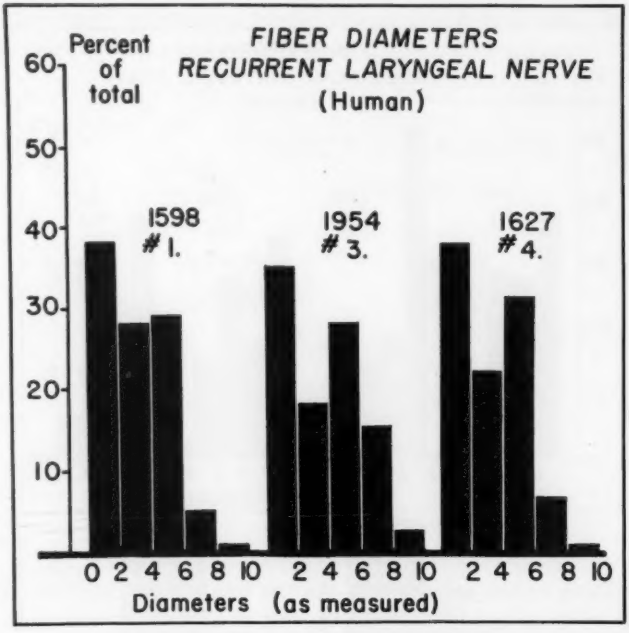

Fig. 2.

There appears to be a general similarity in recurrent laryngeal nerve of the human, the cat and the goat. There seems to be more of very large fibres in the goat than in either the cat or the human, and in each species we have one example where the percentage of smallest fibres is high. We have no record of the locus of these particular sections except in goat B. In this case the record shows that the "middle" of the nerve was the part sectioned. There is a definite possi-

bility that in each of these cases the section was made more peripherally than was the case in the other counts.

So far we have only one nerve from a case of recurrent nerve palsy. The total fibre counts and the percentage representative at various levels in the nerve are shown in Fig. 5. The striking thing in this figure is the low 0/0 representation

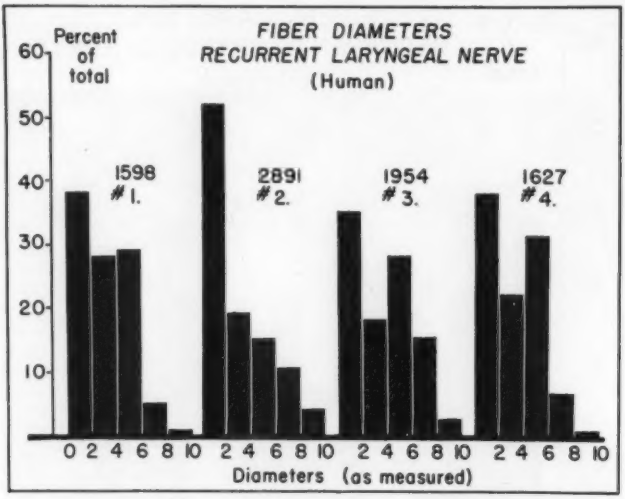

Fig. 3.

of fibres in category 0 to 2. As the total count increases, the 0/0 in the 0 to 2 group goes up, but at all levels it is less than corresponding representations in the "normal" nerves. Since the laryngeal palsy was clinically an abductor paralysis, we think that the relative loss of small fibres is significant and bears out our previous contention that the abductor muscle is supplied by smaller and probably less heavily medullated fibres. More cases must, of course, be collected; it is folly to base any conclusion on a single instance.

In some of the preparations examined but not reported here there was evidence of considerable and widespread de-

generation of the myelin sheaths. This was considered to be postmortem degeneration. In one specimen reported, A-50-26, a patient who died of carcinoma of the colon, this same degeneration was observed, but the preparation was such a good one it was decided to count it anyway. Here the 0/0 counts agree with the other human nerves, and the degeneration has apparently affected all fibre groups, large and small, rather than selecting a single group, *i.e.*, 0 to 2 mm., as in the case of laryngeal paralysis.

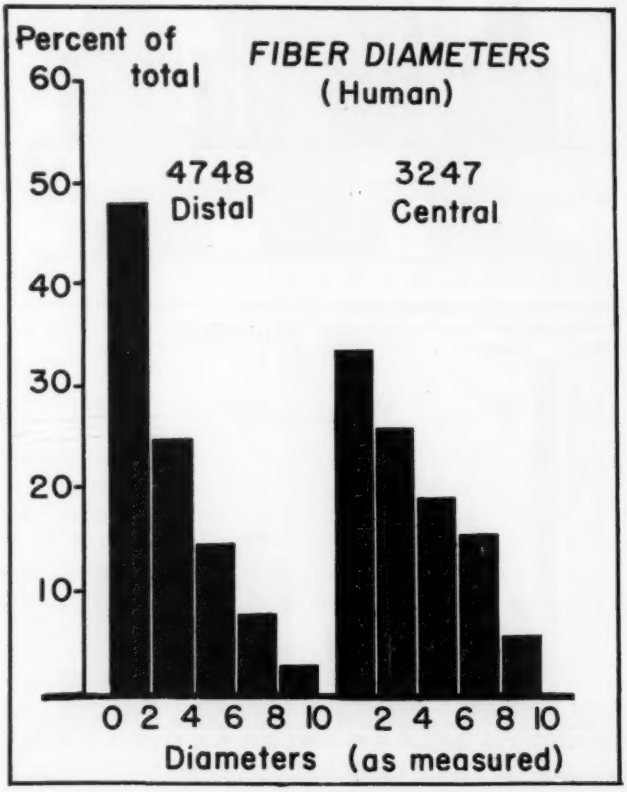

Fig. 4.

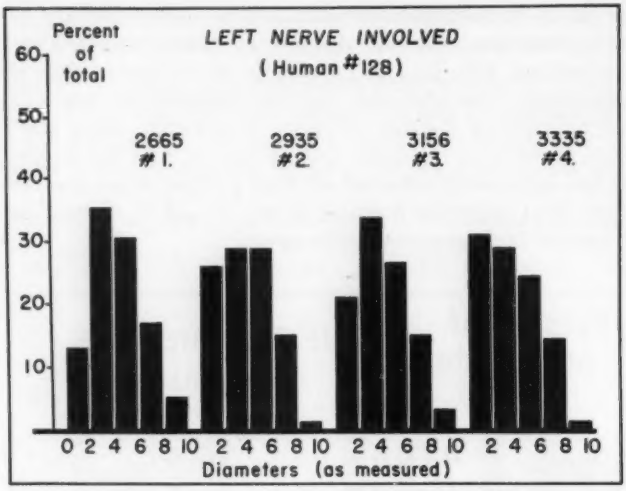
Percent of total
LEFT NERVE INVOLVED
(Human #128)
2665 #1.
2935 #2.
3156 #3.
3335 #4.
60
50
40
30
20
10
0 2 4 6 8 10 2 4 6 8 10 2 4 6 8 10 2 4 6 8 10
Diameters (as measured)

Fig. 5.

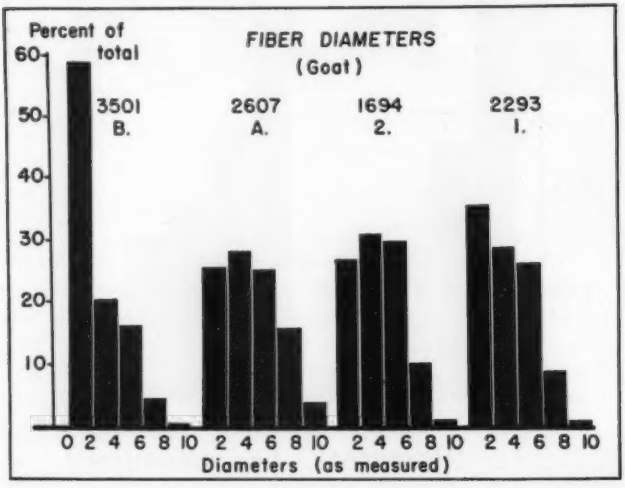
Percent of total
FIBER DIAMETERS
(Goat)
3501 B.
2607 A.
1694 2.
2293 1.
60
50
40
30
20
10
0 2 4 6 8 10 2 4 6 8 10 2 4 6 8 10 2 4 6 8 10
Diameters (as measured)

Fig. 6.

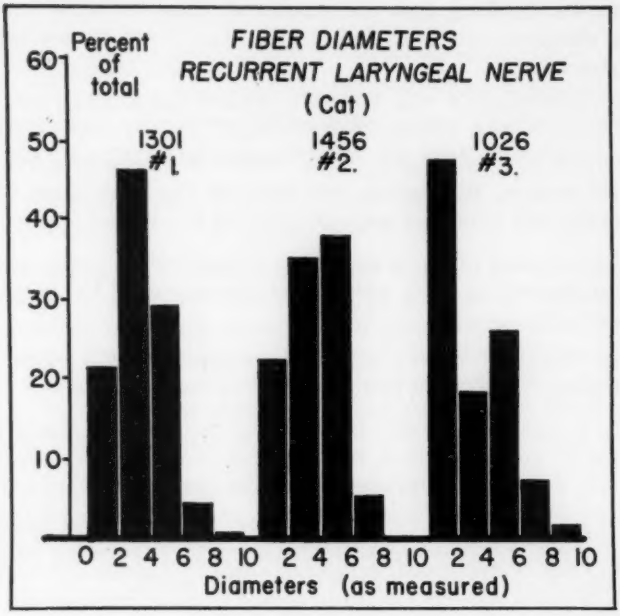

Fig. 7.

DISCUSSION.

The methods employed in this series limit the observations to medullated nerve fibres only. Postganglionic autonomic fibres, being nonmedullated, are not stained and hence are not seen. The recurrent laryngeal nerve is pre-eminently a motor nerve. There is no experimental evidence of sensory function.[3] It undoubtedly contains some afferent proprioceptive fibres. The properties of nerve fibres are conveniently tabulated by Grundfest.[4] Here the diameters of A fibres are given as varying between 1 and 20 micra. The A fibres only are considered to be associated with striated muscle and it is certain that it is with these fibres only that we are dealing. The diameters which we report fall within the group just over 2 micra to just under 17 micra. We have previously reported[1] our rea-

sons for thinking that the smaller of these A fibres supply the abductor muscle of the larynx (*i.e.*, the posterior cricoarytenoideus).

SUMMARY.

The medullated fibres of the recurrent laryngeal nerve of three species, the human, the cat and the goat, have been counted and tabulated according to the size of the fibres.

The number of fibres and the size distribution varies somewhat, depending upon which level the section of the nerve is chosen.

In "normal" nerves, small fibres not over 2.8 micra in diameter, make up 30 to 40 per cent of the population.

In a case of recurrent nerve abductor paralysis, the population of the small fibres, less than 2.8 micra, is most affected by the degenerative process (11 to 31 per cent).

There is evidence (not statistically adequate) that the abductor muscle, as we have previously said, is supplied by the smaller fibres of the recurrent laryngeal nerve.

BIBLIOGRAPHY.

1. MURTAGH, J. A., and CAMPBELL, C. J.: Respiratory Function of the Larynx. Elementary Physiology of Recurrent Laryngeal Nerve. *Ann. Otol., Rhinol. and Laryngol.*, 57:465-472, June, 1948.

2. FULTON, J.: Physiology of the Nervous System. New York, N. Y.: Oxford University Press, 1949, p. 43.

3. MURTAGH, J. A.: Respiratory Function of the Larynx. Some Observations in Laryngeal Innervation. *Ann. Otol., Rhinol. and Laryngol.*, 54:2: 307, June, 1945.

4. GRUNDFEST, H.: Bioelectric Potentials. *Ann. Rev. Physiol.*, 2:214, 1940.

CAUSES AND MANAGEMENT OF ABNORMAL BLEEDING FROM THE AIR PASSAGES ASSOCIATED WITH CERTAIN DISORDERS OF THE BLOOD.*†

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We propose to discuss in this paper a few of the commoner disorders of the blood accompanied by a defective hemostatic mechanism, frequently manifested by almost intractable bleeding from the air passages. Abnormal bleeding wherever it may occur may result from: *a.* A local disturbance in hemostasis. *b.* A systemic disturbance in hemostasis. *c.* Combination of local and systemic defect.

The approach to the management of these disorders should begin by an attempt to trace the possible cause or causes responsible for the bleeding. Bleeding, whether open, or outside of the tissues, or into the tissues themselves, is the result of a temporary upset in the balance between the forces exerting a stress on the blood vessels and the degree to which these forces are offset by the hemostatic function of the body. These forces may originate outside (extrinsic) or inside (intrinsic) the body and, as readily surmised, vary a great deal in intensity, direction and type. In looking for causes of bleeding in any one person, it is well not to overlook the rôle played by these forces in precipitating and maintaining bleeding. Among some of the *intrinsic* forces is the blood pressure (arterial, venous, capillary), the movement of organs such as the tongue, pharynx, stomach and intestines, the expansion and contraction of the lungs. Aside from these, our bodies

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are exposed to *extrinsic* forces resulting from everyday activity, such as blows, infections, contact with chemical irritants, etc. Besides some degree of familiarity with these stress producing forces[1] knowledge of the main factors involved in the natural arrest of bleeding is helpful[2] in deciding the possible causes for *abnormal* bleeding.

The methods at our disposal to bring about systemic or local hemostasis largely mimic the steps that nature has provided for the spontaneous arrest of bleeding in the body. These are as follows:

a. External Compression. When blood is extravasated it accumulates in the tissues, raises the tissue pressure about the open vessel to the point of partially or wholly overcoming the pressure within the vessel. The application of compression to a bleeding wound by means of bandages, tampons, etc., is our way of duplicating this natural mechanism.

b. Contraction and Retraction of the Vascular Wall. When a vessel is severed it will often contract, twist and retract and thereby reduce blood flow. This we attempt to duplicate by, among other things, grasping the vessel with forceps, twisting and ligating it.

c. Formation of the hemostatic plug, into which go some of the formed elements of the blood, especially the platelets and the substances involved in the formation of the clot (prothrombin, fibrinogen, Ac-globulin). By means of transfusions, vitamin K and some plasma fractions, we attempt to supply the deficient or missing components of the natural hemostatic plug.

With this preliminary preparation, let us pass to the discussion of the cause and management of bleeding in patients with leucemia, hemophilia and hemorrhagic purpura.

Abnormal Bleeding in Leucemia. Epistaxis and bleeding from the gums are two common manifestations of acute leucemia, be it lymphoid, myeloid or monocytic, especially towards the latter phases of the disease. Hemorrhage is rarely

observed in patients with chronic forms of leucemia. It is not uncommon for hematologists to have patients referred for study, by nose and throat surgeons or dentists, because of unanticipated bleeding during a tooth extraction, tonsillectomy or adenoidectomy.

Case 1: Mrs. W. K., age 28, during the early part of the Summer of 1949, had a severe sore throat which improved with antibiotic therapy. After much of the inflammation had subsided, tonsillectomy was undertaken. There was more than the usual bleeding during the operation, and sutures were required to stop it. The throat remained red and swollen, and the swelling spread to the gums of the upper teeth and soft palate. The patient developed a high temperature which could not be brought down by antibiotic therapy. It was then noticed that the leucocyte count fluctuated between 30,000 and 40,000 and that most of the cells were primitive monocytes. The platelets numbered 10,000 per cmm. A diagnosis of acute monocytic leucemia was made. The patient died approximately one month after the diagnosis was made and within two months after the tonsillectomy.

Several blood transfusions had been given soon after the tonsillectomy; they helped to reduce and eventually to arrest the bleeding. The early use of antibiotics had probably reduced the swelling somewhat and misled the surgeon into thinking he was dealing with a benign inflammatory disorder.

Difficulty in arresting bleeding after a tonsillectomy, accompanied by subsequent extension of the hemorrhagic or inflammatory process, should lead one to suspect the presence of a systemic disorder.

The cause of abnormal bleeding in acute leucemia has not been entirely elucidated. One or more of the following defects may account for it:

1. Thrombocytopenia.
2. Hypoprothrombinemia.
3. Leucemic infiltration of the vascular walls with consequent necrosis of the vessels.
4. Secondary infection, necrosis and sloughing of the tissues in parts such as the nose, mouth, throat and the lower gastrointestinal tract. The granulopenia that often complicates acute leucemia helps to make possible continuation of the infection.
5. Increase in anticoagulants in the blood.

A rational management of these patients should involve: *a*. Control of the leucemic process, *b*. blood transfusions, whenever possible, to be given by direct method, especiaily if a hemostatic effect is the main objective. *c*. Administration of vitamin K, 5 mg., by mouth or parenterally with hope of raising the plasma prothrombin, if this is reduced. *d*. Administration of vitamin C, 200 mg. daily, to help in the repair of the damaged vessels. *e*. Antibiotics, to combat any complicating infection. *f*. Diminution of exposure to any obvious stresses, thereby automatically diminishing tissue injury and additional bleeding.

All the above objectives can be fairly well carried out at present, with the exception of the first, *i.e.*, control of the leucemic process and the last, *i.e.*, correction of the excess of anticoagulants, when these are present in too high a concentration. Unfortunately we have little or nothing of significant value in delaying or arresting acute leucemia. Until effective methods of therapy for the disease itself have been developed, one must resort to the above measures for temporary control of its hemorrhagic complications. As in other systemic hemorrhagic disorders, it is wise to avoid the application of sutures or excessive or prolonged compression of the bleeding areas, in attempts at local control of the bleeding.

Even in the presence of some of the defects noted above, it is not uncommon to find little or no active bleeding in patients with moderate and severe degrees of thrombocytopenia and hypoprothrombinemia. Compensating forces or limited physical activity on the part of the patient may partially or completely offset the presence of the hemostatic defects.

It is not an uncommon experience to find that the local measures ordinarily proven to be effective in arresting bleeding in normal individuals may prove totally ineffective in patients with a systemic defect in the hemostatic mechanism. Indeed, some of these measures may actually aggravate or extend the bleeding. In general, it may be said that one should resort to only the mildest forms of local measures and depend more upon modifying the hemostatic mechanism systemically.

Compression of bleeding tissues in patients with systemic hemostatic defects should be exerted, not with the avowed objective of driving the blood away from the superficial vessels but with the intention of reducing the rate of bleeding so as to encourage the formation of a hemostatic plug. Since, in patients with these defects, the plug forms slowly, the blood flow from the wound must be slowed, to permit the plug to be formed and acquire the needed firmness to resist the pressure of the blood in the vessels. If excessive compression is placed on a wound, the part is rendered ischemic, and little or no internal plugging of the vessel results; when the compression is removed, the blood will again distend the vessels and flow out of their unplugged ends. Aside from this, a continued ischemia may eventually lead to necrosis, sloughing and extension of the bleeding area.

Chemical or thermal cauterization are frequently used in arresting bleeding from the nose and mouth. While this method in practiced hands is effective in patients with a normal hemostatic mechanism, it often complicates matters in those who have a systemic defect in hemostasis. When using cautery, the physician relies on healing of the wound to replace the cauterized tissue. In patients with defective hemostasis, there is a delay in the rate of healing so that even though cauterization may temporarily arrest the bleeding, when the cauterized skin or mucosa sloughs off, bleeding starts again, and usually from a wider surface than before cautery was applied. This may lead perhaps to a second application of the cautery and temporary hemostasis, subsequent sloughing and a still wider wound. In our clinic, we have had this experience so often that we have warned our colleagues against the use of either chemical or thermal cautery as a local hemostatic measure in these patients. Again, it is preferable to depend upon systemic hemostatic measures than upon local ones. It must be kept in mind that these systemic measures themselves must be maintained throughout the period of healing of the wound, in order to prevent recurrence of the hemorrhage before the wound has reached the stage when it can withstand the effect of motion and local trauma.

Abnormal Bleeding in Hemophilia. There are three clinical forms of hemophilia: *a.* Hereditary — when the disease is found in more than one generation of the same family. *b.* Congenital — when the disease dates from birth, with or without evidence of involvement of other members of the family. *c.* Acquired — when the disease appears spontaneously or as a complication of another disease in a patient who previously did not have the disorder. While the congenital and hereditary types are almost exclusively seen in men, acquired hemophilia may be seen in the male or female.

The defect responsible for the prolonged bleeding in hemophilia results in a delay in the rate of coagulation of the blood and this in turn results from an excess of antithromboplastin activity. Hemophilic blood has all coagulation factors in normal amount and quality, except for the excess of antithromboplastin. This excess slows the rate of transformation of prothrombin to thrombin and thereby the whole process of clotting. Since the rate of clotting is especially important in helping to arrest bleeding from the large vessels, hemophilics experience much of their bleeding in the deep tissues, especially the muscles. The tongue and the pharyngeal muscles are the favorite sites of hemophilic bleeding. These patients seldom bleed from superficial wounds of the oral, nasal or pharyngeal mucous membranes.

A word should be said at this time concerning the application of ligatures to bridge together defects of the skin and mucous membranes with the object of arresting bleeding. In most instances, especially in patients with hemophilia, suturing of parts like the tongue, the bed of a tooth or the tonsillar pillars is to be discouraged, since compression of the underlying tissues obtained by such measures, though appearing to arrest the bleeding from the surface, will often result only in driving the extravasated blood to the deeper layers of tissue which may become so distended as to crowd adjoining areas and interfere with its function.

Case 2: R. F., a known hemophilic, was admitted to Jefferson Hospital in extreme dyspnea. He could not close his mouth or lie down. The day before admission he had had a small laceration of the tongue, which had

been sutured by his family physician. The bleeding was thereby controlled, but the patient noticed that his tongue was swelling until he could breathe only with difficulty, and could not close his mouth. A laryngologist was consulted, who advised aspirating the secretions from the mouth, keeping the patient in a sitting-up position, and being ready to perform a tracheotomy if the swelling became worse. Five hundred cc. of fresh normal blood were given to the patient following the withdrawal of a similar amount from him. Within four hours after the transfusion, the patient's condition became stationary; subsequently he began to improve and was discharged within four days, most of the swelling having disappeared.

The danger of asphyxia from hemorrhages in this area has been discussed in greater detail elsewhere.[3] The patient reported by Endicott[4] died of asphyxia from a hematoma extending around the larynx, after the blood traveled down through the tissues from the original bleeding area, the bed of a recently extracted lower molar tooth. The edges of the wound had been sutured after all attempts to check the bleeding by local and systemic measures had failed. Rather than expose the patient to such hazards, our practice is to exert mild compression in the bleeding area to reduce, but not eliminate, blood flow and to replace blood loss daily, to maintain the blood pressure and allow sufficient time for healing to take place. This may require as many as three weeks and 20 pints of blood. Today, most fatalities in hemophilics rarely result from exsanguination, since the supplies of blood for replacement are now usually plentiful. Hemophilics frequently die from hemorrhage and the resulting compression of organs like the brain, the trachea and upper air passages. The systemic control of hemophilic bleeding is by means of transfusion of blood from normal individuals. One cannot depend too much upon this measure, for its success hinges upon the severity of the hemophilia and the extent of the bleeding area. Often one must be content with replacing the blood, protecting the wound and maintaining the circulation until healing eventually occurs. Hemophilic wounds take from three to five times as long to heal as wounds in normal persons. During this healing period there may be many spurts of bleeding. It is rare that a hemophilic wound does not bleed and stop bleeding several times before the wound heals definitively, and no further hemorrhage takes place.

Abnormal Bleeding in Thrombocytopenic Purpura. In this form of purpura bleeding is manifested especially in the skin and mucous membranes. The mouth, nose and throat are favorite sites. The disturbance in hemostasis is related to the abnormally low number of platelets. This thrombocytopenia interferes with the formation of the platelet plug, which is among the most important steps in the permanent arrest of bleeding from the capillaries and venules where the pressure of the blood is comparatively low. Fortunately in thrombocytopenia there is little disturbance in hemostasis in wounds of large arteries, since vascular and intravascular factors, other than the platelets, share in the arrest of bleeding from these structures. It follows from this, that when accessible, relatively simple measures usually suffice to stop the bleeding locally, even though, often, the arrest may be temporary only. Slight pressure with a tampon having a well lubricated surface is often effective. Even more effective is delineating to the patient measures which will reduce or eliminate any possible stresses that may be exerted upon the bleeding area. For example, thrombocytopenic patients should be encouraged to sleep with the head raised well above the shoulders, to eat a soft diet and to avoid food that requires vigorous chewing or that has sharp edges that may cut the mucosa of the mouth and pharynx. They should be discouraged from undue straining during the passage of stools, for such straining will often precipitate an attack of epistaxis.

When compression is to be exerted upon the bleeding area, as mentioned before, it should be approximately of the order required to blanch the bed of a fingernail. Heavy compression applied with tight packs will result in devitalizing the compressed areas, necrosis of the tissue and more bleeding. The local use of so-called hemostatic substances often produce disappointing results. Frequently, the hemostatic effect really follows the application of pressure by the sponge or other body used as a vehicle to carry the hemostatic agent. If one must be tried, thrombin should be selected and applied on a thin sheet of synthetic absorbable gauze. The gauze holding the thrombin should be gently held against the bleeding sur-

face for about five minutes, so that it will "stick." A loose fitting pack well covered with a lubricant should then be placed over the gauze with the principal objective of maintaining it in contact with the mucosa and exerting light pressure. As soon as convenient and practicable, an effort should be made at the correction of the thrombocytopenia. At present there are only three methods available for this purpose:

1. Transfusion of fresh blood, preferably by the direct method. This may be carried out by the use of silicon coated syringes. In this manner the platelets of the donor are kept from being destroyed by contact with glass during the collection of the blood.

2. Administration of Adrenocorticotropic Hormone or Cortisone. In our hands, this method has been effective in only about one-third of the patients with thrombocytopenia. In almost all instances, once the therapy is discontinued the thrombocytopenia returns.

3. Splenectomy. The decision to carry out this procedure depends upon a number of considerations that we cannot take up now. Suffice it to say that except during an acute emergency, splenectomy should be reserved for those patients with chronic thrombocytopenia not secondary to infection, drugs or metastatic neoplasms, and whose bone marrow contains some megakaryocytes.

Possible Methods of Enhancing Hemostasis. The above remarks have dealt chiefly with well recognized methods of management of these forms of abnormal bleeding. Let us proceed now to consider other possible methods for inducing hemostasis principally by enhancing the coagulability of the blood. Normally the fluidity and coagulability of the blood are maintained by a balance between the amount of procoagulants and anticoagulants in the blood.[5] There are, generally speaking, two ways of increasing the fluidity of the blood:

1. Increasing the amount of anticoagulants or enhancing the effect of the natural anticoagulants in the blood, by adding to it substances like heparin. This is now fairly commonly practiced in the management of thromboembolic disease.

2. Reducing the amount of a procoagulant and thereby enhancing the action of the undisturbed anticoagulants. This is what is done when a decoagulant substance like dicumarol or other prothrombin reducing agents are employed in the management of thromboembolic disease.

What measures then should be taken if the ultimate objective desired is the arrest of hemorrhage by increasing the coagulability of the blood? Logically two approaches are open:

a. Attempt to increase the procoagulants in the blood, especially those that have to do with the initiation of clotting (*e.g.*, platelets), the acceleration of clotting (Ac-globulin), or the substrate of clotting (prothrombin, fibrinogen). So far there are no agents available (with the exception of vitamin K for prothrombin and cortisone and ACTH for platelets) that can be relied upon for this purpose.

b. Reduce the natural circulating anticoagulants and thereby enhance the effect of the natural procoagulants, even when the procoagulants themselves have been reduced by disease, as for example, during the hypoprothrombinemia of hepatic cirrhosis, or in the thrombocytopenia of acute leucemia. This approach would seem to be promising of fruitful results, since the stability of circulating blood and the delay in the inception of clotting is related to the concentration of these anticoagulants (antithromboplastin, antithrombin). Attempts to offset the action of these anticoagulants should render the blood hypercoagulable and to a certain extent enhance the hemostatic mechanism. This applies especially to those instances when the deficiency in procoagulants cannot be corrected by the available means (hypoprothrombinemia refractory to vitamin K, thrombocytopenia of myelophthisic anemia).

Stomatologists and nose and throat surgeons are faced with the problem of controlling hemorrhage much more frequently than that of combating thromboembolic disease. We have been making tentative trials *ex vivo* with agents designed to reduce plasma antithromboplastin activity. Some of these

agents reduce this activity to such an extent that the plasma clots rapidly after addition of small amounts of thromboplastin, even in the absence of calcium. Hemophilic plasma which has an excess of this activity can be made to clot in a shorter time than normal plasma, after being exposed to these agents. It is important to stress that these agents, if and when their use becomes practicable, should be employed with great care and discretion and with a full realization of their intrinsic danger. The field of usefulness for them should be in that group of patients whose excessive bleeding results from a deficiency in prothrombin, platelets or Ac-globulin, but whose anticoagulants (antithromboplastin, antithrombin) are in normal or excessive amount. It may be possible by this means to:

1. Reduce blood loss during operations in individuals with a normal hemostatic mechanism.

2. Prevent excessive blood loss in those with a defective hemostatic mechanism, though the defect may not be caused by any changes in the blood.

3. Reduce or prevent excessive blood loss in patients with defective hemostasis caused by deficiencies in procoagulants or excess of anticoagulants. The neutralization of the natural circulating blood anticoagulants should leave the natural procoagulants of the blood in a position to exert their action more effectively and thereby promote rapid hemostasis.

REFERENCES.

1. Tocantins, L. M.: Fundamental Working Concepts in the Study and Management of Patients with Abnormal Bleeding. *Amer. Prac.*, 2:479, Mar., 1948.

2. Tocantins, L. M.: The Mechanism of Hemostasis. *Ann. Surg.*, 125: 292, Mar., 1947.

3. Fox, J. R.; Spencer, J. T., Jr., and Tocantins, L. M.: Dyspnea in Hemophilia from Hemorrhage Into the Larynx. *Jour. A. M. A.*, 130:78, 1946.

4. Endicott, C. L.; Mitchell, J. H., and Quist, Geo.: Asphyxia Following Dental Extraction in a Hemophiliac. *Brit. Med. Jour.*, 2:34, July, 1942.

5. Tocantins, L. M.: The Maintenance of the Fluidity and Coagulability of Blood. *Surg. Clin. N. Amer.*, Philadelphia Number, Dec., 1949.

MEDICAL AND CYTOLOGICAL DIAGNOSIS OF BRONCHIOGENIC CARCINOMA.*

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It is the intention of this paper to summarize rather briefly the current conclusions regarding bronchiogenic carcinoma as these affect the practice of the clinician. Where new findings are accumulated so rapidly, oftentimes from the point of view of highly technical specialties, a clinical summary is sometimes helpful in reminding us that bronchiogenic carcinoma remains basically a clinical problem.

It is rather strange to find that one of the most discussed questions concerning this disease, and one of the most widely discussed questions in medicine, is statistical. Has there actually been a real increase in the incidence of bronchiogenic carcinoma? The apparent increase is overwhelming. Not too long ago bronchiogenic carcinoma was universally regarded as a rare disease. Today it is a major problem in every chest clinic in the United States. According to some autopsy statistics, there has been a fortyfold increase since 1900. Bronchiogenic carcinoma is now listed as the second most common malignancy of the male sex. We have been interested in carcinoma statistics at the University of California for over a year, and we believe that pulmonary malignancy is actually first in frequency. It is possible that the statistics of the Bureau of Public Health, when they are tabulated, will show bronchiogenic carcinoma the most common form of malignancy in males in this past year, 1950. Deaths from the disease may reach 15,000.

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For a long time many of the people concerned with this statistical problem insisted that the yearly increase in this particular form of malignancy was an illusion, attributable to better diagnosis and so forth. This theory is increasingly hard to maintain. More and more people are accepting the fact of a real increase and are looking around for the reason.

Etiology. From one point of view, the interest in possible etiologic agents for bronchiogenic carcinoma has been quite fruitful. Dozens of such substances have been proven in the laboratory, and several industrial situations, most notably pitch-blende mining and chrome refining, have been proven to be carcinogenic. Such industrial hazards, however, are not really of much significance so far as the question of increased incidence is concerned. Anyone looking over a representative collection of case histories will very quickly be convinced that in not one case out of a hundred is there the remotest possibility that the disease results from some specific industrial situation. With very minor exceptions, bronchiogenic carcinoma is not an industrial hazard.

There have been many attempts to find some factor in the modern environment that might account for the increasing incidence in bronchiogenic carcinoma. Most work has been done on dust which contains petroleum products and on tobacco smoke. Graham, Oxnard and many others have felt that cigarette smoking is a definite factor in the increased incidence. Wynder and Graham recently published a study which was quite impressive. In a comparison of almost 700 patients with bronchiogenic carcinoma with a group of controls of a similar age and sex distribution, they found a significantly higher percentage of steady and heavy cigarette smokers among the patients with carcinoma. A similar study is in progress at the California State Department of Health in which everyone diagnosed as having bronchiogenic carcinoma is being very carefully questioned by trained investigators concerning their smoking habits and other possible etiologic factors. The survey is not complete, but I understand that it looks very much as though this study will bear out the conclusions of Wynder and Graham.

Material. We became interested some time ago in the problem of determining the actual clinical status of bronchiogenic carcinoma. There have been several large and painstaking collections of case histories reported in recent years, but it seemed to us that perhaps these studies did not portray the general situation, because the material was drawn exclusively from teaching institutions and special chest clinics, or cancer clinics. To avoid this, we went back to autopsy material collected from 19 California hospitals which were selected to give us some kind of representative cross-section. We collected 1,070 autopsy reports, and much that I have to say is drawn from this material. We have tried to find out how the disease appeared to the medical profession at large, rather than how it appears to those who are especially interested in cancer.

Symptoms. We did not find anything especially new so far as symptomatology is concerned. The important thing to notice is that bronchiogenic carcinoma is not characterized by particular definite symptoms, but by a group of symptoms. Whenever any of these occur in a person over 30 or 35 years of age, especially of the male sex, they must be investigated and reinvestigated. Cough was, as usual, reported most frequently — a total of 75 per cent. These figures depend ultimately upon the observations of medical students and interne records. We believe that if these patients had been carefully questioned, a history of cough would have been elicited in almost 100 per cent, although in many cases it would be a morning cough not much more severe than that of millions of healthy people. Where, in the interest of our cytological studies, we have pressed the patients to produce sputum, we have found that they can almost invariably produce enough for our needs. The rest of the symptoms reported are those that are commonly found. Weight loss, chest pain, hemoptysis, shortness of breath, hoarseness, complaints attributable to the central nervous system, metastatic masses — these occur over and over in case history analyses. Eighty-five per cent of these patients had some kind of symptom referrable to the chest cage, although it was not necessarily the most prominent complaint.

Physical Findings. The most significant physical findings are tracheal deviation, pleural fluid, wheeze and clubbing of the extremities. A unilateral wheeze is a very significant finding. If it occurs in a male over 35 years of age the only safe procedure is to call it bronchiogenic carcinoma, and then try to rule out this diagnosis. Nineteen per cent of these case histories showed some pleural fluid detectable by physical examination. In the past, pleural fluid has been taken to prove inoperability. It probably does prove inoperability when the fluid is bloody or infected, but in over half of these patients the fluid was clear. Any lung infection can produce clear pleural fluid without directly involving the pleura. This question must be finally answered by the surgeons, but it seems hasty to conclude that pleural fluid indicates inoperability without trying to find out if the pleura really is involved. It should be pointed out that pleural fluid can be almost as suggestive as a unilateral wheeze to a diagnosis of bronchiogenic carcinoma. It is very unusual to see a primary tuberculous pleural effusion in a person over 40 years of age.

Clubbing is also a suggestive finding. It occurred in 9 per cent of the patients in this series. While this deformity can be associated with almost any abnormal pulmonary process, it usually appears only after the pulmonary pathology has become chronic. When clubbing is observed, and there is no history of long standing pathology, bronchiogenic carcinoma must be the first consideration in diagnosis.

In this series of cases, 438 patients, or about 45 per cent of the total studied, had evidence of metastatic lesions when they first presented themselves for examination, or developed such evidence very shortly thereafter. It is this group which is very poorly represented in statistics from teaching institutions or clinics. When the primary condition is recognized as bronchiogenic carcinoma, there is obviously no point in referring such patients for special attention. This group emphasizes the fact that surgery alone can never be a very satisfactory answer to pulmonary malignancy.

X-ray Findings. In this study, adequate Roentgen reports were obtained for only 889 patients. We hear a good deal

about negative X-ray reports in bronchiogenic carcinoma. We had 27 such instances in this series. It is probably well to note that this situation is uncommon, but also to recognize that it exists. For the rest, 65 per cent of these X-rays were read as "suggestive mass," and the balance, 33 per cent, had evidence of atelectasis. These findings were not uncomplicated, however. Pleural fluid tended to obscure the basic condition, and "pneumonia" was very common, 34 per cent. No disease masquerades as something else more commonly than bronchiogenic carcinoma, and it most frequently appears in the guise of pneumonia. Perhaps no single procedure would be more effective against bronchiogenic carcinoma than adopting the custom of X-raying pneumonias after the usual course of antibiotics.

Bronchoscopy. We were rather surprised to find that in these 1,070 cases, only 397 were bronchoscoped. Since this study extended over a period of years, it is probable that at the present time a much greater percentage of bronchiogenic carcinomas are bronchoscoped. The results of these 397 bronchoscopies do not seem to us far out of line with our own experience. In 174 cases, the bronchoscopy was reported as completely negative. In 97, positive evidence of malignancy was obtained; in the balance, comprising one-third of the patients bronchoscoped, some kind of inconclusive evidence was observed. The positive results obtained in this series are perhaps a little low. Herbut and Clerf obtained diagnostic biopsy material in about 34 per cent of 307 patients. We doubt, however, that the 60 to 75 per cent of positive findings which have occasionally been reported can be maintained in a large series of unselected patients. No matter how many mirrors are used, or what techniques for biopsy beyond the field of vision are devised, it looks as though less than half of our bronchiogenic carcinomas are susceptible to bronchoscopic diagnosis. Also, while it is probably not true to say that a positive bronchoscopy indicates inoperability, it is obvious that those tumors most amenable to surgery frequently lie outside the range of the bronchoscopist's vision.

Surgical Results. There is a large question as to whether bronchiogenic carcinoma can ordinarily be considered even potentially operable. We have been able to follow the first 241 cases of bronchiogenic carcinoma diagnosed by our cytological studies. Of this group, 124 were deemed inoperable at diagnosis. The remaining 117 were explored, with five operative deaths. Of these 112 patients, 48 were found to be inoperable when the chest cage was opened; the remaining 64 were resected. To our certain knowledge, there was recurrence within a very short period in 41 of the 64 resections; of the 23 presumed survivals, seven disappeared shortly after the operation. Nine others had a recurrence more than six months after the operation. Of the original 241 cases of bronchiogenic carcinoma, only seven are known to be alive 11 months after the operation.

It is easy to despair when our best efforts can produce less than a 3 per cent survival rate, and these by no means out of danger. We at one time contemplated a paper on the hopelessness of bronchiogenic carcinoma; but, on the other hand, patients with bronchiogenic carcinoma *have* survived for five and even 10 years after their pneumonectomy. We must do the best we can with the techniques that are available. Even if we cannot be sure of these seven survivals out of 241 diagnoses, we can reasonably hope that two to four of these patients will become five-year "cures." We must accept this 1 to 2 per cent survival rate and try to improve upon it. It is obvious that so long as surgery is our only answer to bronchiogenic carcinoma, the cure rate will be low. Probably well over one-half of such growths have metastasized, or otherwise become inoperable, before they produce even moderate symptoms; but if we cannot, with surgery, save 50 per cent, we can perhaps save 20 per cent. A 20 per cent survival rate under the circumstances would be a substantial achievement, and it does not seem unobtainable.

Cytologic Diagnosis. We became interested, about four years ago, in the staining and smearing techniques with which Papanicolaou and Traut were so successful in the diagnosis of uterine and cervical cancer. Since that time we have exam-

ined specimens of sputum and bronchoscopic smears from over 2,500 patients with chest pathology. We are still using the procedure substantially as described in the reports of these men. We have had to modify some of their findings, of course, in the light of our experience with bronchial secretions. In particular, we have found it necessary to insist upon five separate specimens of sputum before we can speak with any assurance, but the method works; it works on early cases, and it works on tumors beyond the effective range of the bronchoscope.

Many pathologists were doubtful of this technique, apparently believing that we attempted to make a diagnosis upon the basis of a single cancer cell. We do not do that. We analyze groups of cells according to several criteria of malignancy. In many respects the technique is more accurate than the examination of sections of tissue by which the pathologist arrives at a diagnosis. In the latter instance, the tissue comes from the fixative shrunken from four to 10 times. The paraffin fixation and staining often further distort the specimen. In the examination of sputum, on the other hand, the cells do not undergo appreciable shrinkage if the specimen is properly handled. Generally the cells we see under the microscope are about eight times the size of those seen in the ordinary H and E preparation. Further, minute details of appearance are retained by the simple process of smearing and staining developed by Papanicolaou and Traut. As a consequence we have been able to establish as criteria of malignancy details that are not even observable in the usual biopsy specimen. Let me say again, however, that we do not depend upon a single criterion. We look for excessive variation in cell size, prominent nuclei, variation in the size and shape of the nuclei, jagged protrusions of the nuclei, irregular condensations of chromatin, the smearing of the chromatin, and so forth. We do not rely on any single one of these appearances. Our first object has been to establish the reliability of the technique; improved sensitivity has been the secondary consideration. We believe that cytologic diagnosis is morphological, if the diagnostician is sufficiently experienced.

REPRESENATIVE CASE HISTORIES.

Case 1: A 61-year-old baker entered the hospital in June, 1948, because of a density in the left lung discovered by a routine X-ray. He had a history of cough for two years previously, which was productive. On several occasions his sputum had been blood-streaked. A positive cytologic diagnosis was made without much difficulty, and within a week of entry a bronchoscopic examination revealed a sanguineous exudate in the left lower bronchus. A left pneumonectomy was performed two days later and an epidermoid carcinoma was discovered. The patient is well and active three years after the operation.

Case 2: A 47-year-old carpenter entered the hospital on June 2, 1949, complaining of pain in the anterior portion of his left chest, which had been constant for four months. Four months earlier, when the pain had begun, a chest X-ray showed a faint shadow in the left upper lung field, and at this time there had been both cough and sputum. At entry into the hospital, the lung shadow was dense, but the cough had disappeared. Tentative diagnosis was tuberculosis, with carcinoma to be ruled out. Eight days after admission malignant cells were found in the sputum. A bronchoscopic examination revealed a deformed carina and purulent exudate in the left bronchus. Malignant cells were also demonstrated in this exudate. The left upper lobe and lingula of the lower lobe were removed. The patient is well at this date.

Case 3: A 70-year-old cook entered the hospital on Dec. 19, 1949, with a diagnosis of pneumonia. An inflammatory process in the right lower lung field cleared with antibiotics. Sputum revealed cells consistent for bronchiogenic carcinoma, although the clinical diagnosis was bronchiectasis or lung obscess. A segmental resection was performed, and pathological laboratory reported only bronchiectasis and inflammatory changes. Further sputum studies were undertaken; malignant cells were still present. The patient died postoperatively. At postmortem a small carcinoma, not larger than a quarter-inch in diameter, was discovered, lying just above the resected portion of the lung.

Case 4: A 66-year-old man had had one sputum specimen positive for acid-fast bacilli and was sent to a sanatorium. An X-ray revealed an area of cavitation. Differential diagnosis was tuberculous abscess or possibly a coccidioidal abscess. Sputum studies revealed malignant cells. A pneumonectomy revealed a tumor lying about the abscess cavity. The patient developed a bleeding duodenal ulcer postoperatively, and died. Postmortem confirmed the finding of coexistent tuberculosis and malignancy.

It is perhaps worth notice that we have collected to date 131 cases of coexistence of pulmonary tuberculosis and bronchiogenic carcinoma. We believe that cytology is revealing carcinoma in many cases of tuberculosis in which, in the past, the malignancy would have been overlooked.

Case 5: A man of 50 years had repeated episodes of hemoptysis, but his X-rays were reported as negative. Studies of sputum samples revealed, however, malignant cells. Bronchoscopy was negative at first, but we continued to demonstrate malignant cells, and repeat bronchoscopy showed an inoperable tumor lying at the carina.

This last case report brings up an interesting situation which has already occurred several times at the San Francisco Hospital. What is to be done when the sputum examination reveals malignancy, but there is no way of determining its location? It is a very difficult position for the physician. In most instances lipiodol will help to locate the tumor body, but occasionally we must continue to utilize special X-ray techniques and bronchoscopy and wait for developments. This is fortunately a rather rare occurrence.

On the whole, we are encouraged with the results that we have obtained with cytology. The number of patients that have been examined by this method is at the present time considerably greater than 2,500, and we have already reported the results from the first 2,000 so examined. In this group, 241 positive diagnoses were confirmed by morphologic methods other than cytology. In another 120 we were able to confirm a diagnosis of metastatic lung cancer. In an additional 121 we made positive findings, but other morphologic evidence was not obtainable.

Of the 241 bronchiogenic carcinomas positively established in this group, the first morphologic diagnosis was made by means of cytology in 47 per cent. In an additional 46 per cent, cytologic diagnosis was made concurrently with diagnosis by some other morphologic technique. Thus, a positive cytologic diagnosis was achieved in 93 per cent of the 241 cases. As has been said, this degree of sensitivity depends upon our securing a minimum of five sputum samples. Where only one is available, we have reported an accuracy of about 55 per cent. Actually, we believe that even one sample is apt to be more accurate than this figure indicates; the overall figures include a good many samples shipped to us from other places, in which the fixing technique was unsatisfactory. We have been able to detect about 70 per cent of the bronchiogenic carcinomas at San Francisco Hospital on the basis of the first sputum sample submitted.

Summary. The clinical problem of bronchiogenic carcinoma is the problem of early diagnosis. On the basis of 6,000 spu-

tum specimens examined, we believe that cytology can contribute materially to that end. It is a simple technique that can be performed routinely, and repeated indefinitely without serious inconvenience to the patient. Cytologic diagnosis is morphologic, and an accuracy of over 90 per cent can be anticipated if five sputum samples are collected. In our experience, virtually every patient can raise sufficient sputum if the physician insists upon it; early morning sputum is most apt to reveal significant findings.

In our experience with 2,000 patients, 241 positive diagnoses of bronchiogenic carcinoma were made. Even with the help of cytology, the survival rate in this group has been very small; however, most of these cases were found among the hospital population. It seems that by the time patients are driven to accept hospitalization for the symptoms of bronchiogenic carcinoma, practically all of them are hopeless. In our studies, we found that the average patient with bronchiogenic carcinoma survived only six weeks after admission. If we are to achieve a material improvement in the survival rate of this disease, we must make our diagnosis before symptoms become alarming.

Dr. Brodie Stephens has suggested that every male over 35 years of age be routinely X-rayed yearly. We concur. But perhaps cytology can contribute significantly to the problem as X-ray. We believe that it should be a routine procedure for every person over 35 who has cough, sputum, inexplicable fatigue, or any other complaint conceivably to be referred to an underlying malignancy. If we can make this routine practice, undertaken long before hospitalization is considered, we can detect a considerable percentage of lung cancers while they are still operable.

BIBLIOGRAPHY.

1. Adler, I.: Primary Malignant Growths of the Lung and Bronchi. New York, N. Y.: Longmans, Green and Co., 1912.

2. Ariel, I. M., *et al.*: Primary Carcinoma of the Lung. *Cancer*, 3:2, Mar., 1950.

3. Farber, S. M., *et al.*: Evaluation of Cytologic Diagnosis of Lung Cancer. *J. A. M. A.*, 144:1-4, Sept. 2, 1950.

4. Farber, S. M.; Benioff, M. A., and McGrath, A. K., Jr.: Diagnosis of Bronchiogenic Carcinoma by Cytologic Methods. *Radiol.*, 51:511, 1949.

5. Farber, S. M., *et al.*: Cytologic Diagnosis of Lung Cancer. Springfield, Ill.: C. C. Thomas and Co., 1950.

6. Farber, S. M., *et al.*: Cytologic Studies of Sputum and Bronchial Secretions in Primary Carcinoma of the Lung. *Dis. Chest*, Sept., 1948.

7. Herbut, P. H., and Clerf, L. H.: Bronchiogenic Carcinoma: Diagnosis by Cytologic Study of Bronchoscopically Recovered Secretions. *J. A. M. A.*, 130:1006, 1946.

8. Moersch, H. J., and Tinney, W. S.: Carcinoma of the Lung. *Minn. Med.*, 26:1046-1051, 1943.

9. Ochsner, A.; DeBakey, M., and Dixon, J. L.: Primary Cancer of the Lung. *J. A. M. A.*, 135:6, Sept. 11, 1947.

10. Papanicolaou, G. N., and Traut, H. F.: Diagnosis of Uterine Cancer by the Vaginal Smear. New York, N. Y.: Commonwealth Fund, 1943.

11. Robbins, G. F., *et al.*: Delay in Diagnosis and Treatment of Cancer. *J. A. M. A.*, 143:346-348, May 27, 1950.

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THERAPEUTIC AND TOXIC EFFECTS OF STREPTOMYCIN IN OTOLOGY.*†

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In this short paper on the therapeutic and toxic effects of streptomycin in otology I intend to make very limited use of only the pertinent literature.

In 1947, J. B. Holt and F. B. Snell were the first to report favorable effects of streptomycin in cases of acute and chronic otitis media caused by the Gram negative proteus bacillus or the Gram negative pseudomonas aeruginosa. Since then the local application of streptomycin eardrops for drying of a chronic suppuration of the middle ear has proven effective in many cases. H. A. Carithers claims that acute otitis in infants caused by pseudomonas aeruginosa responds very favorably to the injection of 40 to 75 mg. of streptomycin every four hours for an average of six days. B. H. Senturia recommends application of a streptomycin solution of at least 0.5 per cent for the local treatment of the external auditory canal in cases of otitis externa diffusa.

In the ear, however, as is the case in all other regions of the body, the effect of streptomycin on the tubercle bacillus is much more impressive and important. Every otologist knows from his own experience how tiresome and thankless a task the conservative as well as the surgical treatment of tuberculous affections of the ear formerly were. Previously the course of a tuberculous otitis media has depended greatly upon the development of the basic tuberculous affection, which in most cases is a pulmonary tuberculosis. A large defect in the

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tympanic membrane and scar formation in the middle ear with severe loss of function were the best results one could expect in a tuberculous otitis media. Greif and Gould were the first to achieve healing of the perforation in two cases of tuberculous otitis media by the intramuscular application of streptomycin. In another case intramuscular and local application of streptomycin led to rapid healing of the wound and of the perforated tympanic membrane after bilateral mastoidectomy. Léon L. Titche confirms these first successes of streptomycin in a larger number of cases. In 32 patients with tuberculous otitis media, involving 35 ears, healing of the perforation occurred in 18 ears; improvement in 11 ears, in which, with the perforation remaining open, the discharge ceased without recurrence during the time the patient was under observation; six ears showed no improvement. Streptomycin was applied locally by instillation into the middle ear in four patients, leading to improvement in three cases and healing of the perforation in one case.

Thanks to the help of my former co-worker, U. Russi, who until a short time ago was working at the famous lung health resort Davos, we can confirm and supplement the favorable results of streptomycin in our own experience with 101 cases of tuberculous otitis media. So far we have not encountered one case of the previously fatal tuberculous otitis media in an infant. In the opinion of prominent pediatrists, however, every case of infant tuberculosis involving the lungs or any other organ is an absolute indication for intramuscular application of streptomycin. Judging from the success of this therapy in other parts of the body, the prognosis of infant otitis media tuberculosa will most likely also be improved by this treatment.

The 101 cases of tuberculous otitis media observed by us from 1946 to 1950 occurred in the course of pulmonary tuberculosis, probably by hematogenic dissemination. In about 50 per cent of our cases the affection of the ear began with severe earache without any pronounced disturbance in the general condition of the patient. A few days later secretion

of a creamy pus set in, in which tubercle bacilli could be demonstrated in the direct smear in about 50 per cent of the cases.

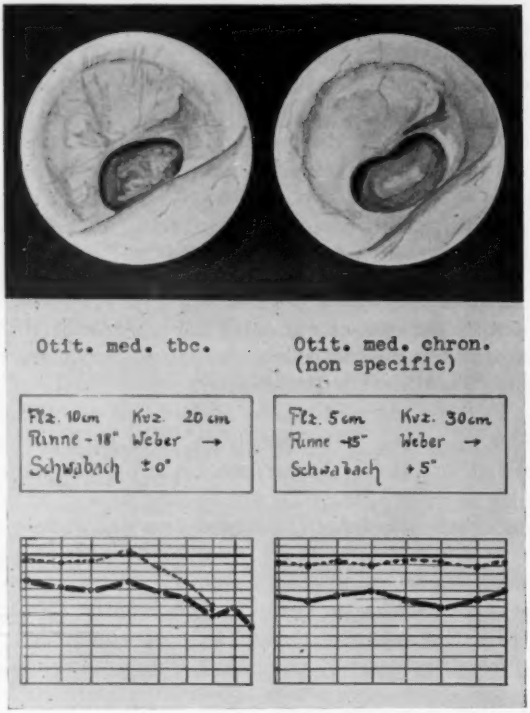
Otit. med. tbc.
Flz. 10cm Kvz. 20 cm
Rinne - 18" Weber →
Schwabach ± 0"
Otit. med. chron. (non specific)
Flz. 5cm Kvz. 30cm
Rinne +15" Weber →
Schwabach + 5"

Fig. 1. Comparison of otitis media tuberculosa with nonspecific otitis media chronica.

A single rapidly growing perforation of the tympanic membrane is found more often than multiple defects which soon merge. In those parts of the tympanic membrane which are primarily still intact, yellow spots are often seen. These are specific infiltrations of the pars mucosa shining through the outer layers of the tympanic membrane. Even at the onset of the disease the air cells of the mastoid process appear veiled in the X-ray picture.

Deafness beginning at a very early stage and progressing rapidly, audiometrically shown to be a combination of impaired sound-conduction and sound-perception, strongly points to a tuberculous affection of the ear.

In the beginning, nerve deafness might even be more pronounced than middle-ear deafness, probably due to a tuberculotoxic irritation of the labyrinth. With the further progress of necrosis of the tympanic membrane and the ossicles, however, impairment of sound-conduction grows decidedly worse, often to the extent of total deafness. Close attention to all symptoms suspicious of tuberculosis has become a very important task today, because the earlier streptomycin treatment is begun the better is the prognosis of the case.

In about 50 per cent of our cases the tubercle bacilli cannot be found, and our diagnosis is based entirely upon the clinical symptoms. Treatment with streptomycin is instituted immediately. U. Russi claims that the best results are obtained by the local application of streptomycin. For this purpose the external auditory canal, the perforation in the tympanic membrane, and the tympanic cavity are cleaned as well as possible. A 10 per cent solution of streptomycin in water is then sprayed as an aerosol into the middle ear and, if possible, into other parts of the pneumatic system, at least once a day over a period of weeks, or, perhaps, even months. Most resistant to this therapy are those cases of tuberculous otitis media in which extensively pneumatized mastoid processes are found.

I find that the best therapeutic results in exudative tuberculosis of the middle ear are obtained by combining the local administration of streptomycin with the parenteral administration. The antibiotic injected intramuscularly is taken by the blood at least to the edges of the tuberculous foci which lie in the mucous membrane and in the bone of the mastoid. By this procedure further spreading of the tuberculous process into deeper structures may be prevented. For this purpose a total of at least 60 gm. of streptomycin in daily maximal doses of 24 mg. per kg. body-weight should be administered.

On the other hand, the locally applied streptomycin directly attacks the tubercle bacilli in the ulcerations and granulations in the mucous membrane of the tympanic cavity.

If the tubercle bacilli are resistant to streptomycin, treatment with a 20 per cent para-amino-salicylic-acid solution should be attempted. By local application of para-amino-salicylic acid combined with marbadal (a thiocarbamide preparation) Schuermann has achieved cessation of ear secretion, fading of the inflammation of the eardrum, clearing-up of the mastoid process with new calcification of the bone, and an increase in hearing distance.

U. Russi is now working on a thorough statistical evaluation of his cases. It is possible that when he has finished this work my statements today may have to be corrected. By the local administration, as described above, cessation of middle ear suppuration, healing of the eardrum perforation, and a marked improvement of hearing was achieved in only five cases of specific otitis, although 77 cases of tuberculous otitis media were observed from their onset and streptomycin treatment was instituted immediately upon perforation of the eardrum. Herewith is a brief report of one of these rare cases.

Case 1: B. M. The patient is a 23-year-old girl with a cured pulmonary tuberculosis (see Fig. 2) and onset of a purulent otitis media in May, 1947. Tubercle bacilli were found in the pus and in the adenoid vegetations removed in August, 1947. On Aug. 18, 1947, the left ear showed a markedly thickened, yellowish-red colored tympanic membrane with a large central perforation. In the granulating mucosa of the tympanic cavity there were a few caseous foci. Hearing distance in the affected ear for whisper was 15 cm.; for conversational voice, 150 cm. Local therapy with streptomycin was begun immediately. Within 10 days the ear secretion ceased and within five weeks the hearing distance for whisper increased to 500 cm. At this time the eardrum was dry and thickened by scar tissue. There was still one small perforation in the anterior lower segment. Nine weeks after beginning of the treatment the hearing distance for whisper was 600 cm. The perforation in the scar-thickened eardrum was closed. The streptomycin treatment was discontinued. In June, 1948, January, 1949, August, 1949, and January, 1950, short recurrences of acute inflammation without perforations occurred in the right ear, accompanied by a decrease to 20 to 30 cm. in the hearing of a whisper with each recurrence. On July 14, 1950, the tympanic membrane was markedly thickened, but not irritated. The hearing distance on the left ear for whisper was 200 cm. and for conversational voice, 800 cm. The audiogram showed an average air-conduction loss of 25 db over the entire frequency range. The patient has been under constant control since then with no recurrence.

As I have pointed out, such healing is very rare in our experience but by the local application of streptomycin we have achieved definite improvements in 94 of 101 cases of tuberculous otitis media. In these cases ear secretion ceased within one to three weeks. In about 30 per cent of all cases there is a recurrence of purulent otitis, partly specific and partly nonspecific in nature. It can also be arrested promptly

by a second and third local treatment with streptomycin. Cessation of the secretion probably parallels a certain degree of stabilization of the disease process. The eardrum perforations, therefore, usually do not expand, and destruction of the ossicles ceases. In our 101 cases we found no further complications in the mastoid processes or in the endocranium. Re-

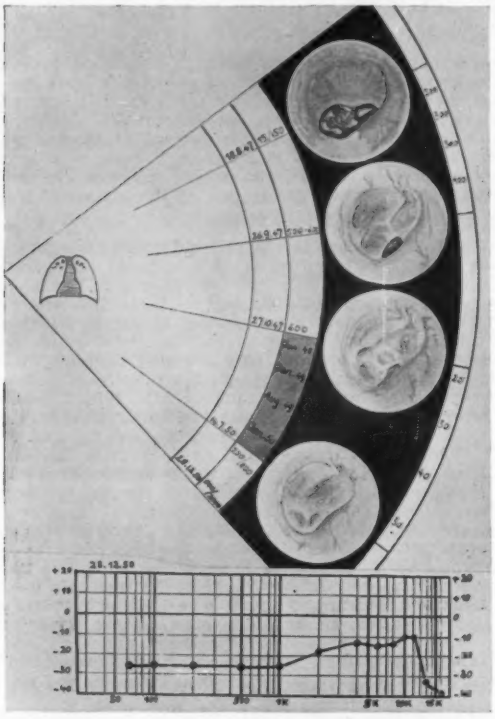

Fig. 2. Twenty-three-year-old girl with pulmonary tuberculosis. Healing of otitis media tuberculosa dextra after local therapy with streptomycin.

garding the loss of hearing, however, once such a loss has manifested itself, the success of the streptomycin treatment in this large group of merely improved cases shows considerably less satisfying results. Disregarding a few slight

improvements of hearing, the hearing loss found at the onset of the treatment usually remains unchanged. Remembering, on the other hand, from experiences of the past, the stabilization of the process damaging the hearing, or the preservation of the intact remnants of hearing, must be considered successful therapy. The success of the streptomycin teatment in these merely improved cases may be challenged by a nonspecific new infection of the open middle ear or by a recurrence of the old tuberculosis.

It is a pity that we have no histological slides of tuberculosis of the middle ear treated with streptomycin.

Most textbooks emphasize the fact that tuberculosis of the middle ear clinically manifests itself as a suppuration. Marx claims that the assumption of older authors that there also exists a dry form of tuberculosis of the middle ear with only an infiltration of the mucosa of the tympanic cavity without exudation has not proven true. My co-worker, U. Russi, however, has seen 25 cases of chronic infiltrative tuberculosis of the lungs, in which the middle ear, behind an intact eardrum, was found to be the seat of a proliferative and infiltrative tuberculosis.

The diagnosis of such a tuberculosis of the middle ear is based on the following: The disease of the ear usually begins with a rapidly increasing deafness combined with a feeling of fullness in the ear. In the beginning there is a striking discrepancy between the rapidly increasing loss of hearing and the slight changes found on the tympanic membrane. The audiogram, at the onset at least, shows that the nerve deafness is more pronounced than the conduction deafness. On the tympanic membrane one first finds a slight inflammation in the region of the manubrium, or a radial injection of the peripheral vessels without retraction of the membrane. Later, the eardrum slowly thickens and the landmarks are obliterated. Yellow foci are often found in the pale red membrane, representing the infiltrations in the submucosa. Along with these alterations in the tympanic membrane hearing grows increasingly worse with a more pronounced conduction

deafness. Sometimes it progresses to the point of total deafness. This condition may prevail unchanged for months. Only upon improvement of the basic disease, such as an infiltrative pulmonary tuberculosis, does the proliferative-infiltrative tuberculosis of the middle ear gradually subside. The tympanic membrane, though pale, remains thickened, and recovery of hearing is very rare.

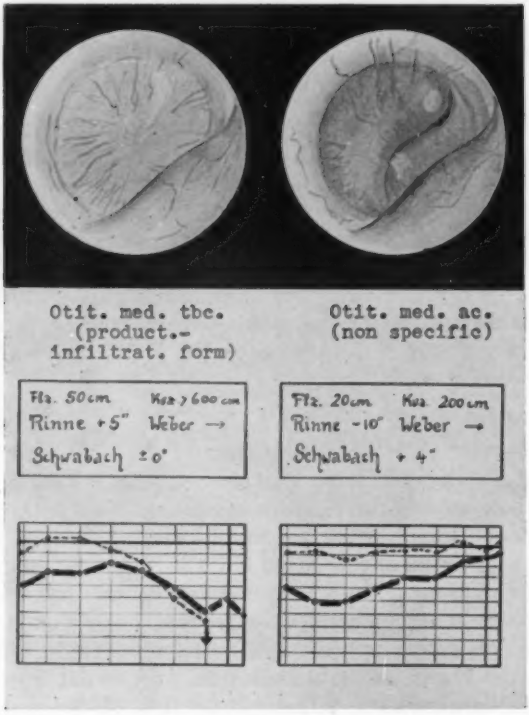

Fig. 3. Proliferative-infiltrative tuberculosis of the middle ear, compared to the characteristic changes and the audiogram in acute otitis media.

U. Russi reports that streptomycin treatment has no noticeable direct effect on the course of a proliferative-infiltrative tuberculosis of the middle ear. At best the antibiotic, by

means of its favorable effect on the pulmonary disease, indirectly aids in the healing of the infiltrative tuberculosis of the ear. In our opinion, the specific infiltrations of the middle ear respond so poorly to streptomycin that it helps to prove the tuberculous nature of the infection. In these infiltrations,

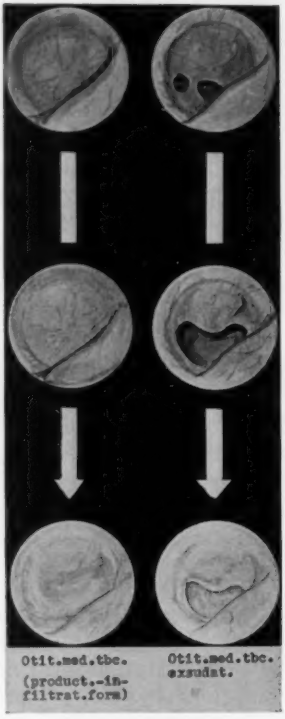

Fig. 4. Healing of a proliferative-infiltrative tuberculosis of the middle ear, and improvement of an exudative tuberculosis of the middle ear.

bacilli are so thinly spread in a tissue supplied by only very few blood vessels that they can hardly be reached by the streptomycin. The very poor tendency toward recovery of hearing, once it has become impaired, also fits into the pic-

ture of a proliferative tuberculosis of the middle ear; for at best, the specific granulation tissue is replaced by scar tissue which continues to interfere with sound conduction.

Until recently the otologist has been more interested in the toxic effects rather than the therapeutic effects of streptomycin on the ear. The clinical applicability of this new antibiotic seemed questionable. On the other hand, the specific effects of streptomycin on the vestibular labyrinth opened certain possibilities for the exploration of functions of the inner ear. The question of its clinical applicability can now be considered as solved, because we know that loss of hearing as well as disturbances of the vestibular apparatus to a great extent may be avoided by adjusting the dosage of streptomycin to the weight of the patient. For this purpose the daily doses should not exceed 24 mg. of streptomycin per kg. bodyweight, providing the kidneys function normally; furthermore, toxic disturbances of equilibrium and hearing occur even less frequently upon parenteral administration of dihydrostreptomycin instead of streptomycin. C. M. Domon, P. C. Kilbourne and E. Q. King gave a total of 270 gm. of dihydrostreptomycin in daily doses of 3 gm. to an adult without any toxic effects. In our comparative animal experiments the far slighter toxic effects of dihydrostreptomycin have been confirmed.

Van Goidsenkoven and R. Stevens urgently advise against the intrathecal and parenteral application of hydrated streptomycin in tuberculous meningitis. In 173 cases, observed by them over a period of two years, they found decidedly more cases of toxic impairment of hearing after treatment with dihydrostreptomycin than after streptomycin treatment.

The cause of this peculiar sensitivity of the auditory apparatus to the hydrated antibiotic is not known as yet; however, the toxic effects of streptomycin continue to be of theoretical interest even when the therapeutic problems have been solved. The following is a brief description of the functional changes observed in human patients and in animal experiments.

Symptoms from the vestibular apparatus are the first signs of intoxication in the human patient. The vestibular disturbance manifests itself as vertigo occurring when the patient in bed moves his head. This is accompanied by disturbances in vision such as blurring of the surroundings and fogginess. As soon as the patient stops moving his head the dizziness disappears. The disturbance of equilibrium becomes particularly noticeable when the first attempts to walk are made. Following a certain amount of training, the patient is able to walk, at least with his eyes open, but with broad, hesitant steps like a drunken sailor. The surroundings sway before him, and in order to see clearly he must stand still. As soon as he stops walking the dizziness disappears. The Romberg test reveals only a slight swaying in no specific direction. Only occasionally is this dizziness accompanied by a spontaneous nystagmus. Experimental stimulation of the vestibular apparatus through caloric irritation and rotation during the period of dizziness leads to a bilateral decrease and finally to disappearance of the nystagmus. Occurrence of these vestibular disturbances depends upon the amount of streptomycin given. On the other hand, a loss of hearing very seldom occurs even when large doses of streptomycin are given; furthermore, the connection between streptomycin and deafness is not so clear, because in most cases of deafness a tuberculous meningitis is present which might in itself have caused the impairment of hearing. In several of these an improvement of hearing resulted when the streptomycin treatment was stopped, and in some cases, treated with streptomycin, a hearing loss developed in the absence of a tuberculous meningitis.

The special symptoms produced by streptomycin on the statoacusticus are an indication of the seat of the lesions.

A combination of a bilateral disappearance of vestibular irritability with intact hearing, typical for streptomycin intoxication, has already been noted by Guettich in the case of a brain tumor, localized in the floor of the fourth ventricle, as proved by autopsy. The tumor touched the vestibular nuclei. This region was histologically examined by Stevenson and his co-workers in five cases of tuberculous meningitis

treated with streptomycin and in three dogs after the application of large doses of streptomycin. In these five clinical cases, and in these three animals, pathological changes were found in the ganglion cells of the nucleus cochlearis ventralis. In addition, two cases showed necrosis, diminution of cells, and hydropic degeneration of the nucleus vestibularis inferior.

For our own streptomycin experiments we used guinea pigs rather than dogs and cats, since the latter animals are both difficult to obtain and usually of various breeds.

In a first series of guinea pigs treated with streptomycin the histological examination of the animals' petrous bones revealed normal structures in the cochlear and vestibular areas of the internal ear. On examining the serial sections of the guinea pigs' brains we found a decrease in the number of ganglion cells and some glia nodules in the floor of the fourth ventricle in the nucleus triangularis of the VIIIth cranial nerve. We also observed slight changes in the form of plasma vacuolization in the nucleus cochlearis ventralis, and nuclear pycnosis within the ganglion cells.

Shortly afterwards, the late R. Caussé for the first time noticed a loss of sensory hairs in the peripheral vestibular apparatus of three mice poisoned with streptomycin, showing marked disturbance of equilibrium. In additional investigations, Caussé confirmed his first findings of pathological changes within the peripheral vestibular apparatus. The loss of sensory hairs appeared as a secondary process following the degeneration of the sensory cells of the cristae and maculae.

In a second series of experiments, performed on a mouse poisoned with streptomycin, Caussé found degenerative changes in the first cochlear turn of the organ of Corti. The absence of external and internal hair cells was accompanied by a degeneration of the corresponding nervous elements ascending to the ganglion spirale, which showed a decrease in the number of cells. This was followed by K. Berg's report of similar pathological changes in the peripheral auditory organ of streptomycin-poisoned cats which presented distinct disorders of equilibrium.

The cat which had received the highest dose of streptomycin showed no traces of the organ of Corti in the lower and middle cochlear turns. On the same animal the author also observed a certain impairment of hearing.

After Caussé's first communication we reviewed our series of guinea pigs without being able to detect the loss of sensory hairs either on the cristae or on the maculae, which Caussé declared to be characteristic. Assuming that our doses of streptomycin (total doses of 6 to 8 gm) might have been too small to produce visible histological changes in the peripheral organ, we administered to another series of guinea pigs total doses of 6 to 30 gm. of streptomycin in order to control the data reported by Caussé and Berg. Aside from the effects of streptomycin on the vestibular apparatus, we were interested also in a hearing loss due to streptomycin. For the control of

Streptomycin - Intoxikation in guinea-pigs.

Nr	Gewicht g	Einzel-Dosis g	Tage	Gesamt Dosis g	g/kg	Kost-Reakt.	Pinna-Reflex	Cochlea-Effekt
1298	480	0,09 0,08 0,09	33	6,59	13,7	path	0	0
1919	760	0,08 0,09 0,08	99	13,85	18,4	path	0	0
1984	550	0,08 0,09 0,08 0,1 0,12 0,15	160	13,61	24,7	path	stark abgeschwächt	abgeschwächt
1916	600	0,08 0,09 0,08 0,1	128	21,37	35,5	path	stark abgeschwächt	abgeschwächt
1409	550	0,08 0,09 0,08 0,1 0,12 0,15	160	30,69	55,8	path	stark abgeschwächt	abgeschwächt

Fig. 5. Table showing body weight, doses of streptomycin, duration of treatment, results of the equilibrium tests and the sound-perception tests.

sound-perception we first determined during and after the treatment with streptomycin the threshold of Preyer's pinna-reflex for several test sounds which were conducted to both ears simultaneously. Second, we measured on the streptomycin-poisoned animal's right ear the aural microphonic effects immediately preceding vivifixation, as described by Wever-Bray.

For histological examination we finally prepared the petrous bones and the brain of the vivifixed animal, cut them in series, and stained them.

In our experiments with streptomycin five animals gave results which were completely investigated. Table 5 shows body weight, doses of streptomycin administered, duration of treatment, and the results of the equilibrium tests, together with those of the sound-perception tests. All guinea pigs show more or less clearly the typical phenomena of irritation and deficiency of the vestibular apparatus; furthermore, all animals showed a loss of sound-perception to a varying degree during the administration of streptomycin.

The histological examination of the petrous bones reveals changes in the sensory endings within the peripheral vestibular apparatus though varying in extent, similar to those first described by R. Caussé in the ear of the mouse, and afterwards by K. Berg in the ear of the cat. In guinea pigs' ears our findings were: *1.* the cristae (see Figs. 6 and 7) and maculae display a distinct reduction of sensory epithelium.

Fig. 6. Normal crista ampullaris.

This forms a band in which numerous dark and nearly round nuclei can be recognized but frequently without cellular outlines or cuticular border. The injury starts in the sensory cells, which gradually disappear, while the supporting cells

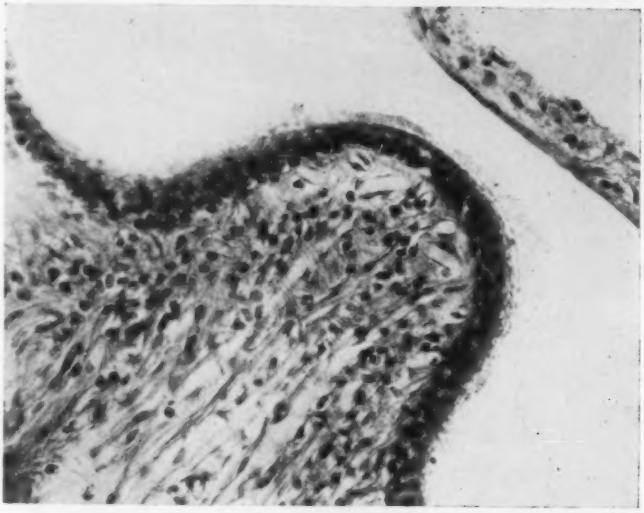

Fig. 7. Crista ampullaris after streptomycin treatment.

swell and perhaps even multiply, as described by Caussé. Generally the cristae ampullaris and the maculae utriculi show more changes than the maculae sacculi (see Fig. 8).

2. The degeneration of sensory cells is accompanied by the loss of sensory hairs, beginning with the loss of single hairs and then expanding over a larger surface.

3. Histological examination of the cochlear apparatus of the streptomycin-injured guinea pig's ear reveals more or less pathological changes in all animals, particularly in the organ of Corti, fundamentally similar to the findings of R. Caussé in one mouse, and K. Berg in one cat. In the guinea pig No. 1298 the organ of Corti (see Fig. 9) disappeared symmetrically on either side of the entire area of the first turn. Where

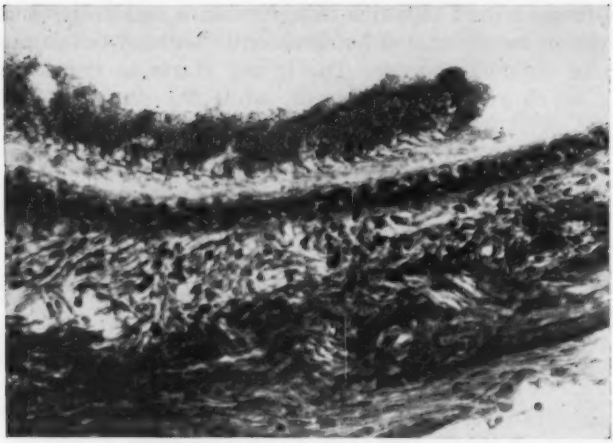

Fig. 8. Macula utriculi after streptomycin treatment.

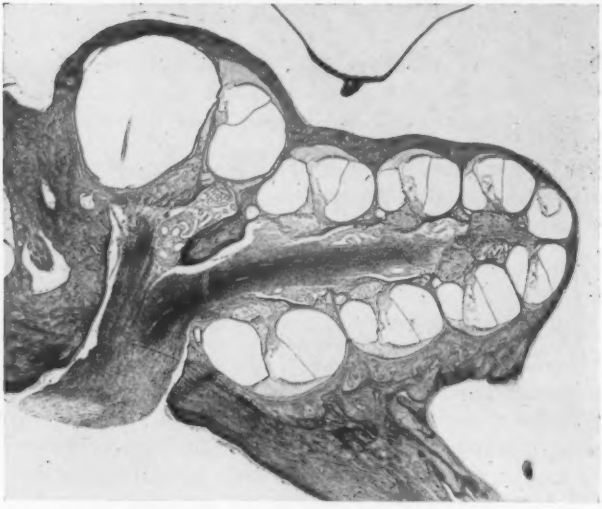

Fig. 9. Cochlea of the guinea pig showing the disappearance of the organ of Corti in the first turn, after treatment with streptomycin.

the organ of Corti has disappeared (see Fig. 10) an ascending degeneration of afferent nerve fibres of the ganglion spirale, changes in the ganglion spirale itself, and further degeneration of the fibres leading to the VIIIth cranial nerve can regularly be demonstrated. The stria vascularis, situated in front of the destroyed organ of Corti also exhibits marked pathological changes.

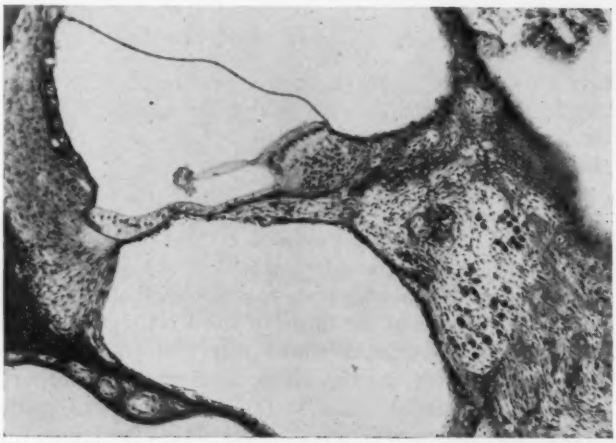

Fig. 10 Ascending degeneration of the nerve fibres after treatment with streptomycin.

Histological changes of principally the same kind but of varying degree were found in the inner ear of five guinea pigs poisoned with streptomycin.

The histological examination of the central nervous system of the streptomycin-injured guinea pigs, as in our former findings, shows certain pathological changes in the form of isolated glia nodules and some degeneration of ganglion cells, located in the area of the vestibular nuclei on the bottom of the fourth ventricle and in the nucleus cochlearis ventralis. There is, however no proportion between the extent of these minor pathological signs and the functional loss. Contrary to

our opinion voiced two years ago, we now consider these nuclear changes as nonspecific for streptomycin injury.

Following these observations made on animal experiments, my co-worker, K, Graf, examined the histological structure of the petrous bones of patients treated with streptomycin from a more comparative point of view. Since these histological slides, however, came from 24 patients who also suffered from tuberculous meningitis, the histological evaluation of the hearing losses and the histological proof of the changes in the inner ear developed into a very hard task.

In 22 cases the response of the vestibular apparatus to caloric stimulation disappeared during the course of the intrathecal and intramuscular treatment with streptomycin. Six of the 24 cases developed deafness in both ears, one case in one ear.

Histological examination revealed a tuberculous meningitis in the meatus acusticus internus of all 48 petrous bones. Three cases, of which only one was deaf in both ears, show degenerative changes of the fibres of the VIIIth cranial nerve. None of the 48 labyrinths shows any histological signs of inflammation. There is, therefore, a marked disproportion between the functional losses in the vestibular and cochlear apparatus and the morphological tuberculous alterations found in the ear.

Differential histological examinations of the sensory endings of the ear were successfully carried out in 11 of 24 patients, three of the six being totally deaf. In nine of these 11 cases, signs of degeneration were found in the sensory cells of the maculae and cristae of the vestibular apparatus (see Fig. 11). In addition to these changes we noticed a loss of hair cells in the lower and middle turns of the organ of Corti in all three totally deaf cases (see Fig. 12).

These degenerative changes found in the sensory endings of the human ear agree to some extent with the histological alterations experimentally produced in animals by the administration of streptomycin. From this we conclude that the

impairment of the vestibular and cochlear apparatus occurring in 24 patients with tuberculous meningitis during streptomycin treatment is at least partially caused by streptomycin.

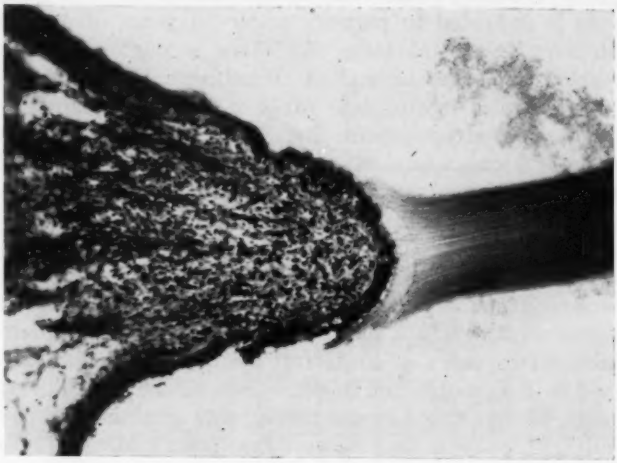

Fig. 11. Crista ampullaris in man after treatment with streptomycin.

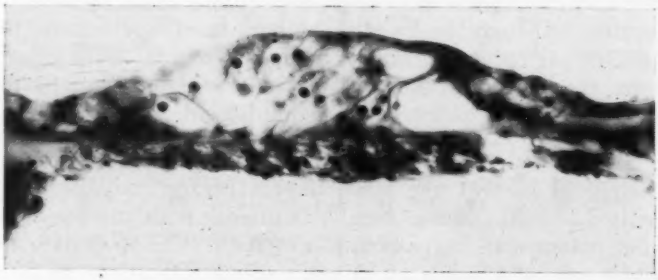

Fig. 12. Organ of Corti in man with loss of hair cells after treatment with streptomycin.

While working on the toxic effects of streptomycin on the vestibular apparatus, it occurred to J. Hawkins that this drug might be used to prevent the attacks of vertigo in Ménière's disease. Thereupon, E. P. Fowler, Jr., treated four

cases of bilateral Ménière's disease and corresponding bilateral deafness with large doses of streptomycin, giving 4 gm. per day at the rate of 0.5 gm every three hours during three to four weeks. Fowler reached the conclusion that streptomycin is indicated in patients under 50 years of age when customary treatment fails, and there is bilateral deafness. At about the same time C. A. Hamberger, H. Haydén and H. J. Koch also treated four cases of Ménière's disease with large doses of streptomycin. By the daily parenteral administration of 3 gm., a total of 90 gm., two of these cases of bilateral Ménière's disease were kept free from vertigo attacks for a period of five months without any further loss of hearing. Toxic losses in the function of the vestibular apparatus, which manifest themselves around the tenth day of treatment, disappear from one to four months after the end of the streptomycin treatment but continue to be experimentally demonstrable. Two cases of unilateral Ménière's disease also received 3 gm. daily, but a somewhat smaller total dosage, namely, 66 and 55 gm., respectively, was administered parenterally. These patients, too, were free from a Ménière's dizziness at the end of the streptomycin treatment. On the other hand, they suffered severely for months from the functional disturbances of the vestibular apparatus caused by streptomycin. Although the Swedish authors tried to eliminate the affected ear only and made checkups by means of the caloric tests, the sound ear, too, was injured for a long time by the large quantity of streptomycin administered.

Based on these experiences and on the discovery of the peripheral seat of the streptomycin injury, we, too, have treated several cases of Ménière's disease with smaller doses of streptomycin. Three examples of the results up to date are given.

The first case, a 38-year-old man, who for two years has been suffering from bilateral Ménière's disease with marked impairment of hearing in both ears (see Fig. 13) and attacks of dizziness becoming more frequent. The customary conservative methods of treatment mitigated the attacks for only very short intervals. A labyrinth operation at this moment was abstained from on account of the bilateral deafness. A first streptomycin treatment with a total of 24 gm. of streptomycin, given in daily doses of 2 gm., was carried out on this patient weighing 73 kg. On the eleventh

day of treatment the patient began to feel slightly unsteady, and treatment was stopped on the following day. The caloric irritability of the vestibular apparatus was somewhat decreased on both sides, the patient felt greatly relieved and remained symptom-free for two months. A new light vertigo attack combined with nausea then occurred, and again we treated him with 2 gm. of streptomycin daily, giving a total of 40 gm. On

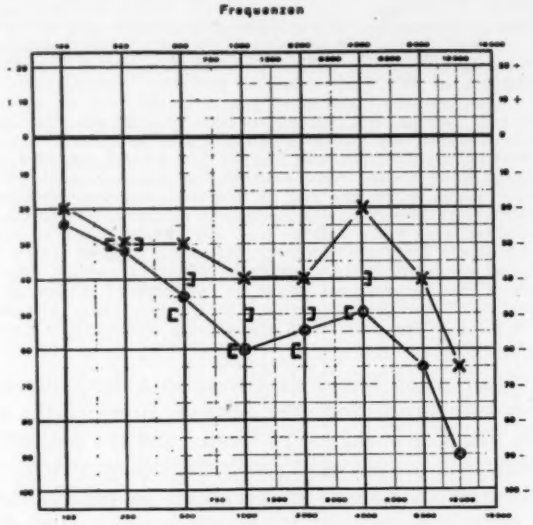

Fig. 13. Thirty-eight-year-old man with bilateral Ménière's disease. Audiogram.

the thirteenth day of treatment the first disturbances caused by streptomycin began. The patient felt a pressure in his head and a disturbance of his balance upon moving his head. A week later treatment was stopped again. The vestibular apparatus on either side still showed weak responses to caloric stimulation. The toxic disturbances subsided within six weeks. For five months the patient has been completely symptom-free and able to work. The hearing showed neither subjective nor objective changes during the treatment with streptomycin.

Both in its symptomatology and in its response to streptomycin this case confirms the observations made by Fowler and Hamberger; however, by giving smaller single doses of streptomycin and by keeping the total doses considerably smaller, an equally good therapeutic result was achieved in the course of two treatments without total loss of response to caloric stimulation by the vestibular apparatus.

The second case, a 43-year-old woman with congenital deafness, who had suffered from severe attacks of rotatory vertigo and vomiting for eight years. Various conservative methods of treatment, attempted by otologists, neurologists and neurosurgeons, were unsuccessful. Testing of the vestibular apparatus showed in addition to a very vehement response of the vegetative system, a weak response of the right labyrinth to caloric stimulation, and a spontaneous nystagmus to the left was observed during an attack of dizziness; therefore, a right labyrinthotomy was done, as described by Cawthorne. The attacks of dizziness recurred. A similar operation on the left ear seemed contraindicated, despite the total bilateral deafness, because of the danger of creating a lasting disturbance of the equilibrium in this very sensitive patient. Instead, this woman, weighing 46 kg., received 3 gm. of streptomycin daily for eight days, or a total of 24 gm. During this time the patient vomited severely, and fluid in the form of saline and glucose solution had to be given intravenously. Nine days after streptomycin was stopped, the nausea subsided and the vertigo attacks disappeared. While reading, the patient noticed blurring of type. Three weeks after the end of the streptomycin treatment the patient, completely free from dizziness, was discharged from the clinic. A slight unsteadiness while walking was still present, but that condition, too, soon subsided. We abstained from performing another caloric test on the vestibular apparatus of this extremely sensitive patient. Her condition remained good for one year. Then, in the Summer of 1950, an attack of dizziness with vomiting occurred. Since then these attacks have recurred monthly. The results of the second streptomycin treatment, begun a short time ago, remains to be seen.

This rare case of Ménière's disease in a deafmute patient should serve to demonstrate the situation in which the seat of Ménière's affection could not be located and the patient's condition could not be relieved by labyrinthotomy, but in which by relatively small doses of streptomycin the patient was free for one year from the vertigo attacks which had previously resisted all other therapeutic measures.

The third case is a man, aged 43, with severe vertigo without subjective impairment of hearing. Examination revealed a spontaneous nystagmus in all positions, partly rotatory, partly horizontal-rotatory to the right, becoming more pronounced with shaking of the head. Caloric and rotatory stimulation pointed to a hypersensitivity of the right labyrinth. In the audiogram (see Fig. 14) the depression of the air-conduction curve on either side of 2,000 c.p.s. is more pronounced than usual in a patient of this age. As all other measures failed to cope with the acute attack, 2 gm. of streptomycin daily for four days were administered, making a total of 8 gm. One hour after each injection severe dizziness occurred which subsided the moment the patient lay down. The nausea which constantly annoyed the patient before subsided immediately following the first injection of streptomycin. Two days after the streptomycin treatment was completed the patient, now free from dizziness, left the hospital. On the street he saw people in a certain distance somewhat blurred, and for three weeks he felt very tired. Then, suddenly, he felt perfectly well. He walks and sees normally, and his hearing is intact. No further vertigo attacks occurred for three months. In this case, too, we abstained, for the time being, from a second caloric examination of the vestibular apparatus.

This case represents a first attempt to treat Ménière's disease in its beginning with streptomycin. Since we know today that the antibiotic first affects the peripheral vestibular apparatus, I feel safe in recommending this treatment in cases which are resistant to the customary remedies. That is, providing the doses are kept small and administration of streptomycin is stopped at the right moment.

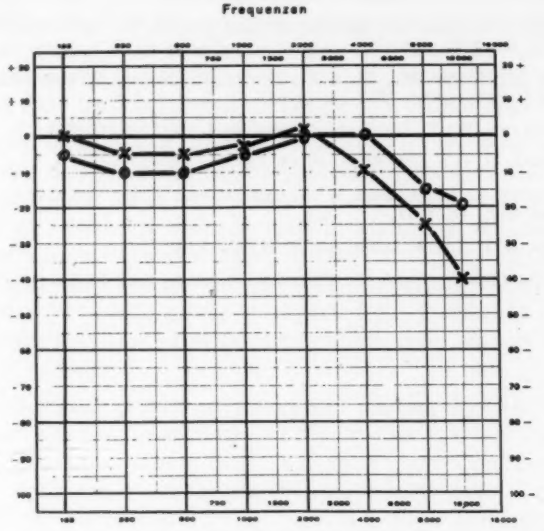

Fig. 14. Forty-three-year-old man with Ménière's disease (first attack). Audiogram.

BIBLIOGRAPHY.

BERG, K.: *Ann. Otol.*, 58:448, 1949.

CARITHERS, H. A.: *Jour. Pediat.*, 36:767, 1950.

CAUSSE, R.: *Ann. d. Otolaryngol.*, 66:518, 1949; *Rev. d. Oto-Neuro-Ophth.*, 20:473, 1948; *C. R. Soc. Biol.*, Mai, 1949; *C. R. Acad. Sci.*, Avril, 1949.

DOMON, CH. M.; KILBOURNE, PH. C., and KING, E. Q.: *Amer. Rev. Tuberc.*, 60:5, 1949.

FOWLER, E. P., and GLORIG, A.: *Ann. Otol.*, 56:2, 1947.

FOWLER, E. P.: *Trans. Amer. Acad. Ophth. and Otolaryngol.*, 3:293, 1948.

GREIF, J. L., and GOULD, J. W.: *Arch. Otolaryngol.*, 48:209, 1948.

GUTTICH, A.: Neurologie des Ohrlabyrinths. Leipzig: G. Thieme, 1944.

HAMBERGER, C. A.; HYDEN, H., and KOCH, H. J.: *Arch. Ohr., usw. Hk.*, 155:667, 1949.

HAWKINS, J.: Zit. nach E. P. Fowler.

HOLT, J. B., and SNELL, F. B.: *Arch. Otolaryngol.*, 45:169, 1947.

MARX, H.: Kurzes Handbuch d. Ohrenheilkunde. Jena: G. Fischer, 1947.

RUEDI, L.; FURRER, W.; ESCHER, F., and LUTHY, F.: *Acta Otolaryngol.*, Supp. 78, 66, 1949.

RUEDI, L.; FURRER, W.; GRAF, K.; LUTHY, F.; NAGER, G., and TSCHIRREN, B.: THE LARYNGOSCOPE, 1951 (in print).

SCHURMANN, F.: *Z. Laryngol., Rhinol. and Otol.*, 30:27, 1951.

SENTURIA, B. H.: *Ann. Otol.*, 56:81, 1947.

STEVENSON, L. D.; ALVORD, E. C., and CORREL, J. W.: *Proc. Soc. Exper. Biol. and Med.*, 65, 1947.

TITCHE, L. L.: *Arch. Otolaryngol.*, 51:826, 1950.

VAN GOIDSENKOVEN and STEVENS, R.: *Schweiz. Med. Wchnschr.*, 80:104, 1950.

SUBMUCOUS RESECTION OF THE INFERIOR TURBINAL BONE.*†

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Many local procedures have been advocated in the literature for the relief of perennial nasal obstruction due to enlargement of the inferior turbinate, which cannot be controlled by more conservative general measures. Recent resumés of this subject have been presented by Dixon[1] and Richardson.[2]

Partial or complete inferior turbinectomy has been largely discarded due to the profound physiologic changes such surgery produces; more conservative procedures, however, are beneficial. Such procedures include stripping the turbinal mucosa with a caustic drug or by electrocoagulation. In my experience this has proved to be of temporary value and if carried out too extensively or repeated too frequently results in fibrosis and altered physiology, which may produce symptoms of atrophy.

Intramucosal caustic solutions and electrocoagulation likewise are popular local methods of reducing turbinal enlargement. These procedures produce fibrosis within the cavernous spaces rather than on the surface and are, therefore, preferable to the surface scarifying methods. Care must be taken not to enter too deeply into the soft tissue. Should the cauterizing agent disturb the periosteum of the turbinal bone prolonged discomfort and often sequestration may result.

Submucous resection of the inferior turbinal bone is not a new procedure. Yankhauer, in his student lectures, advocated resection of the inferior turbinal bone, but I have not uncov-

*Presented before the Mid-South Postgraduate Medical Assembly, Memphis, Tenn., Feb. 13, 1951.

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ered any writings by him on this subject. Harris[3] advocated submucous resection of the middle turbinate in chronic ethmoid disease.

Although this operation has not been popularized in the literature, I find it is being used by a few rhinologists throughout the country. Because it has been a most satisfactory procedure in my experience, I feel justified in making this report.

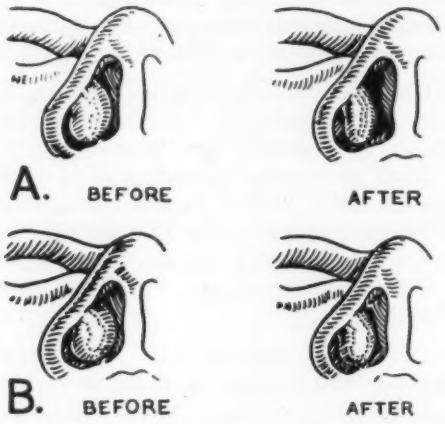

Fig. 1. (A) Thin turbinal bone. Turbinate shrinks markedly, revealing thin turbinal bone. Intramural cauterization probable procedure of choice in this type. (B) Thick turbinal bone. Turbinate shrinks very little, revealing thick turbinal bone. Submucous resection procedure of choice in this type.

INDICATIONS FOR SURGERY.

Submucous resection of the anterior portion of the inferior turbinal bone is of most value in perennial nasal obstruction due to turbinal enlargement, either unilateral or bilateral, which cannot be satisfactorily controlled by more conservative general management. Included in this group are vasomotor rhinitis, allergic rhinitis, compensatory unilateral hypertrophy secondary to septal deviation, and irreversible

Fig. 2. Cross-section of inferior turbinate reveals rough indented character of turbinal bone surface.

hypertrophy secondary to prolonged irritation. This underlying irritation may be due to infection, occupational environment, excessive smoking, etc.

If the inferior turbinate remains large after thorough shrinkage, it indicates the anterior portion of the turbinal bone is thick. If the turbinate becomes small, it indicates the anterior portion of the turbinal bone is thin. The thicker the turbinate after nasal shrinkage the better the result will be following submucous resection.

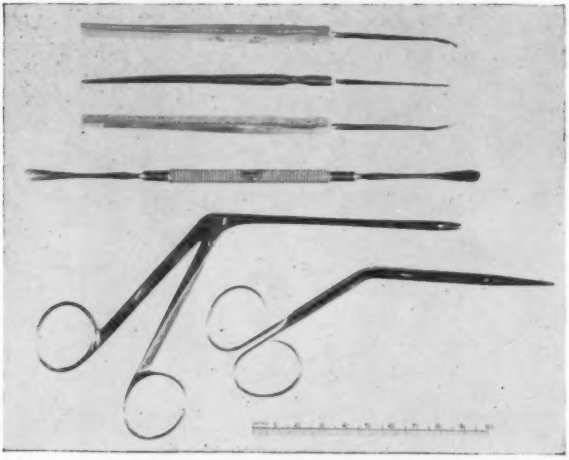

Fig. 3. Instruments for submucous resection of inferior turbinal bone. (1) Right and left angulated and straight Freer knives. (2) Freer elevator used to fracture the inferior turbinate. (3) Takahashi ethmoid forceps used for fracturing and removing the anterior portion of the turbinal bone. (4) Small turbinal scissors used for separating the mucosa along the inferior margin of the turbinal bone.

If, after nasal shrinkage, the inferior turbinate is very small it indicates a paper-thin anterior turbinal bone with marked soft tissue enlargement. In these cases intramural coagulation, either by caustic solutions or by the bipolar cautery as advocated by Hurd,[4] Owens[5] and others is probably the procedure of choice.

SURGERY.

Surgery of the inferior turbinal bone may be unilateral or bilateral and performed singly or in conjunction with a submucous resection of the nasal septum. We do not advocate this procedure in persons under 16 years of age. The success of this operation depends upon removing the thickened anterior portion of the inferior turbinal bone with a minimum amount of trauma to the surrounding mucosa.

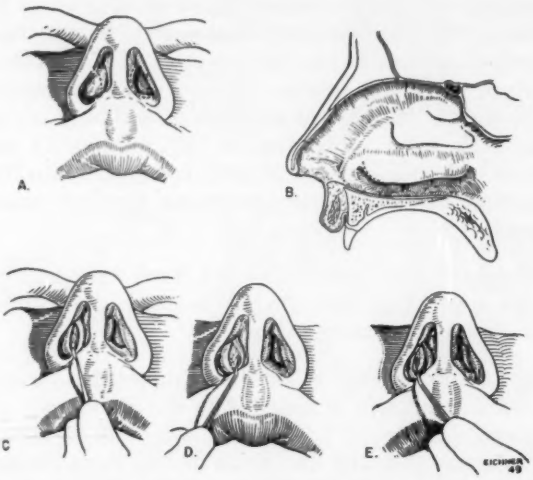

Fig. 4. (A) Dotted line indicates incision directly over the anterior inferior leading edge of the underlying turbinal bone. (B) Incision viewed laterally. (C) Straight Freer knife or No. 15 Bard Parker exposes the leading edge of the thick inferior turbinal bone. (D) Left angulated Freer knife is used to elevate the mucoperiosteum along the medial anterior one-third of the turbinal bone. (E) Right angulated Freer knife repeats the process on the lateral surface of the turbinal bone. Care must be taken not to fracture the turbinal bone attachment before elevation is complete.

The anterior portion of the inferior turbinal bone has a rough and irregular indented surface; therefore, the mucoperiosteum cannot be separated with a blunt elevator, as in septal surgery. A right and left angulated Freer knife, as made by Storz for the purpose, is used to separate the mucoperiosteum by sharp dissection from the lateral and medial

surfaces of the anterior portion of the inferior turbinal bone. Tearing of the covering mucosa is thereby avoided.

A small, long-nosed nasal turbinal speculum, as designed by G. O. Proud[6] (the Proud turbinal speculum), is useful as an aid in visualizing the area involved.

TECHNIQUE.

Submucous resection of the anterior portion of the inferior turbinal bone may be performed either as an office or hospital procedure. Premedication and local anesthesia are used as in submucous resection of the nasal septum. Epinephrin-soaked applicators dipped in cocaine flakes are used to anesthetize both the medial and lateral surfaces of the inferior turbinal mucosa. One cubic centimeter of "K" solution (1 per cent novocaine with epinephrin 1:50,000) is injected into the anterior portion of the inferior turbinate for hemostasis and anesthesia.

A straight Freer knife, or No. 15 Bard Parker, is used to make the original incision directly over the anterior inferior leading edge of the turbinal bone.

With the cutting edge of the blade directed inferiorly, the angulated Freer knife is inserted to the previously exposed leading anterior edge of the turbinal bone. By repeated small cutting strokes and with the point of the knife always hugging the roughened turbinal bone, the mucosa is separated from the bone largely by sharp dissection. The mucoperiosteum is elevated for a distance of 1.5 cm. from the anterior leading edge of the turbinal bone. This distance represents the anterior one-third of the turbinal bone and characterizes its thick portion. Care must be taken not to apply excessive pressure on the turbinal bone during this elevation. If fracture occurs before the mucoperiosteum is separated from the medial and lateral surfaces, further separation is most difficult due to the mobility of the underlying fractured bone. For this reason the lateral side of the turbinate is separated first, and if fracture should inadvertently occur, the medial surface is

more readily visible, and the lateral wall in the nose can be used as a support while the mucoperiosteum separation is completed from the medial aspect of the turbinal bone.

After separation of the mucoperiosteum from both the medial and lateral surfaces of the bone has been completed for a distance of 1.5 cm., or approximately one-third the

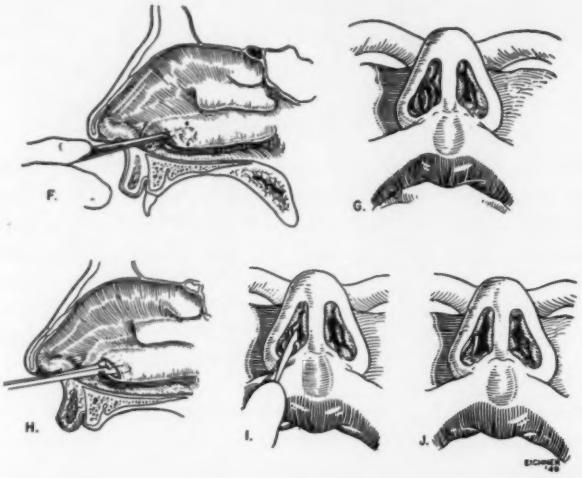

Fig. 5. (F) Illustrates motion of Freer knives. (G) Completely separated mucoperiosteum. Scissors are used to complete this process along inferior margin of turbinal bone. (H) Takahashi forceps is ideal for grasping and removing anterior one-third of the turbinal bone. (I) Elevator is used to fracture remainder of turbinate laterally. (J) New position of thinned inferior turbinate. Note increased nasal airway.

length of the inferior turbinal bone, the attachment of the mucoperiosteum is severed from the inferior edge of the inferior turbinate for an equivalent distance with the small turbinal scissors. The anterior thick portion of the inferior turbinal bone, which is now separated from the mucoperiosteum in its entirety, is grasped with the Takahashi forceps, rotated, fractured, and gently removed.

If there is a tendency for the bone to cling to the mucoperiosteum, additional exploration must be done to determine the area of continued attachment. This attachment is then

severed completely with the scissors. Forcible removal of the bone in this instance will tear the mucosa and result in altered physiologic surface changes which we are striving to avoid.

Fig. 6. Cross-section of inferior turbinate before and after removal of inferior turbinal bone.

The remaining two-thirds of the turbinal bone is tissue paper-thin and need not be removed. A Freer elevator is used to infract the remaining bone, first medially and then laterally. This immediately opens the nasal airway and if the posterior tip of the turbinate is bulbous or papillomatous in character, it can be cauterized or removed with a small snare, as the operator may choose.

Sutures are unnecessary and the procedure is completed by inserting a double finger cot between the septum and turbinate and packing it with suitable gauze. This is removed the following morning. The bleeding encountered is little more than that of a submucous resection of the nasal septum. The postoperative convalescence is free of discomfort with the exception of the usual postoperative turbinal edema. Improvement in breathing is perceptible within 48 hours, and maximum benefit is obtained after complete healing occurs several weeks later.

COMMENTS.

Additional intranasal airway is obtained by this procedure through removal of the thickened anterior portion of the inferior turbinal bone. This space, which is previously occupied by turbinal bone, now collapses, allowing the medial and submucosal layers of tissue to draw together, thereby reducing the overall size of the inferior turbinate. Such a change is permanent in character.

Since the underlying anterior support has been removed and the thin remaining portion of the bone fractured laterally, the turbinate now rests in a more lateral position, thereby creating still additional intranasal space. This altered position does not interfere with drainage from the orifice of the lacrimal duct. Subsequent swelling of the soft tissue, due to whatever the underlying uncontrollable etiologic agent may be, is now permanently less effective in obstructing the space between the septum and the inferior turbinate.

After a technique is developed and the procedure is properly performed there is but a minimum degree of interference with the physiology of the secreting turbinal mucosa.

A total of 125 bilateral cases, in which only the turbinates were disturbed, were operated upon prior to 1948. This group was selected for this study because the interval of two years was deemed sufficient to note any delayed physiological changes which may have resulted from the procedure.

Of this total, 23 cases have been discarded due to incomplete follow-up examinations and questionnaires.

Dear

I am attempting to evaluate the results of our nasal surgery and would appreciate you answering the following questions:

Question	Yes	No
1. Did you have difficulty breathing through your nose before surgery?.....	—	—
2. Do you now breathe satisfactorily through your nose?.....	—	—
If you do not breathe satisfactorily through your nose, Is your breathing 75% better?	—	—
50% better?	—	—
25% better?	—	—
Unchanged?	—	—
Worse?	—	—
3. Did you have difficulty with crusting in your nose before surgery?.....	—	—
4. Do you now have difficulty with crusting in your nose?.....	—	—
5. Did you have postnasal discharge before the operation?.....	—	—
6. Do you now have postnasal discharge?.....	—	—

Please make any comments you may desire.

Fig. 7. Results were tabulated both by the above questionnaire and postoperative observation.

SUMMARY.

Irrespective of valiant attempts to control cases of turbinal enlargement by general therapy, a certain percentage of cases have proven unmanageable in my experience. Various local methods of surface and intramural scarification have been used in an attempt to improve the nasal airway of these individuals.

	Preop.	Postop.
Crusting	48 or 47%	52 or 51%
Postnasal discharge	65 or 63%	58 or 57%

Fig. 8. There was no significant change in the degree of crusting before and after surgery. This would indicate little tendency toward atrophic changes. Only 6 per cent of the cases revealed a significant decrease in the amount of postnasal secretion. This would indicate increased ventilation does not necessarily aid in diminishing postnasal discharge.

Submucous resection of the anterior one-third of the inferior turbinal bone has given our best results in selected cases. This is especially true if the inferior turbinate remains relatively thick after thorough shrinkage, thereby indicating a thickened underlying turbinal bone in its anterior portion.

Complete relief of obstruction	47 or	46%
75% relief of obstruction	19 or	18%
50% relief of obstruction	14 or	14%
25% relief of obstruction	5 or	5%
Unchanged	14 or	14%
Worse	3 or	3%
	102 or	100%

Fig. 9. The above figures indicate the majority of patients were either totally relieved or approximately 75 per cent improved two years or more after having had a submucous resection of the inferior turbinate performed.

CONCLUSION.

1. Submucous resection of the anterior one-third of the inferior turbinal bone is recommended for uncontrollable perennial inferior turbinal enlargement.

2. The procedure is herein described in detail together with certain instruments developed specifically for the operation.

3. A study of 102 cases over a two-year period indicates a favorable response to this surgery.

4. This operation reduces the size of the inferior turbinate with a minimum of interference to the physiology of the turbinal tissue.

REFERENCES.

1. Dixon, Fred W.: The Nasal Turbinates. *Trans. Amer. Acad. Ophth. and Otolaryngol.*, Nov.-Dec., 1949.

2. Richardson, John R.: Turbinate Treatment in Vasomotor Rhinitis. The Laryngoscope, 58:834-847, Aug., 1948.

3. Harris, Harold I.: Improved Technique for Submucous Turbinectomy. *Ann. Otol., Rhinol. and Laryngol.*, 45:481-484, June, 1936.

4. Hurd, Lee M.: Bipolar Electrode for Electrocoagulation of the Inferior Turbinate. *Arch. Otol.*, 13:442, 1931.

5. Owens, Harold: Paper read at California State Medical Meeting, San Diego, Calif., May, 1950.

6. The G. O. Proud Turbinal Speculum (a personal communication).

RAPID ANTIBIOTIC SENSITIVITY DETERMINATIONS FOR PSEUDOMONAS AERUGINOSA ISOLATED FROM EXTERNAL OTITIS.*

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INTRODUCTION.

One of the major problems encountered in the therapy of otitis externa infections is the lack of information concerning the etiologic agent involved and the sensitivity of the causative agent to the available antibiotics or other therapeutic agents. Several workers[1,3,7] have reported that a large proportion of the cases of otitis externa are infected by *Pseudomonas aeruginosa (Bacillus pyocyaneus)*.

This paper reports procedures that reveal in a relatively short time the presence of *P. aeruginosa* and its reactions to a battery of several antibiotics and to a drug, sulfamylon. Sulfamylon (p-aminomethylbenzene-sulfonamide) has been shown to be a very effective treatment for infections with *P. aeruginosa* as the etiologic agent.[2,4,5,6]

MATERIALS AND METHODS.

The studies were performed on 54 cultures of *P. aeruginosa* obtained from frank cases of otitis externa.† Each isolation was made from a specimen collected on a sterile cotton-tipped swab and placed in a test tube containing brain-heart infusion broth. This was brought immediately to the laboratory, where the required culture procedures were done. Two media were

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†The patients were seen in the Department of Otorhinolaryngology, School of Aviation Medicine.

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employed: Proteose No. 3 blood agar, because it promotes excellent growth of microorganisms usually found in the ear; and an asparagin agar because the blue-green pigmented colonies of *P. aeruginosa* were easily detected on this medium within the period of incubation employed. Separate plates of blood agar and asparagin agar were inoculated with each of the contaminated swabs. The plates were streaked with an inoculating loop so as to produce a surface covered with isolated colonies. At the end of 18 to 24 hours' incubation at 37° C. the plates were examined for colonies characteristic of *Pseudomonas* species. Such colonies were picked to slants of Kligler's iron agar medium and incubated overnight to determine their reactions. Those cultures with the usual appearance of *Pseudomonas* were subjected to certain of the criteria listed for this genus.[8] Cultures identified as *P. aeruginosa* were employed in this study.

The brain-heart infusion broth, Kligler's iron agar, and proteose No. 3 agar (to which 5 per cent defibrinated rabbit blood was added) were made from dehydrated culture media.* The asparagin agar was formulated in this laboratory, as follows:

Asparagin	3.0 gm.
Bacto-tryptose	5.0 gm.
Dextrose	2.0 gm.
Dipotassium phosphate	2.0 gm.
Magnesium sulfate	1.0 gm.
Potassium nitrate	0.5 gm.
Bacto-agar	20.0 gm.
Distilled water	1,000 ml.

Heat to boiling to dissolve the agar, adjust the pH to 7.2 and sterilize in the autoclave 15 minutes at 15 pounds pressure. Cool to 47° C. before pouring plates.

The sensitivity of these *Pseudomonas* organisms to several antibiotics and to sulfamylon was determined by the following method: The surface of a culture plate (asparagin agar) was inoculated with an 18- to 20-hour culture of the test organism. With a sterile, cotton-tipped swab a drop of the culture (1:1,000 dilution) was spread over the entire surface of the

*Bacto-Difco Laboratories, Detroit, Mich.

medium. Filter paper disks impregnated with various concentrations of each of the antibiotics and of the sulfamylon were then placed on the culture. A general method for the use of these disks has been described.[9]

The three different concentrations used for each of the antibiotics and the sulfamylon were labeled A, B and C (see Table 1).

TABLE 1.

LIST OF THERAPEUTIC AGENTS USED IN DETERMINING THE SENSITIVITY REACTIONS OF PSEUDOMONAS AERUGINOSA.

Test Agent	Concentration A	B	C
Sulfamylon*	15 mcg.	40 mcg.	160 mcg.
Chloromycetin†	10 mcg.	30 mcg.	60 mcg.
Terramycin	10 mcg.	30 mcg.	60 mcg.
Dihydrostreptomycin	0.5 mcg.	1.0 mcg.	10 mcg.
Streptomycin	0.5 mcg.	1.0 mcg.	10 mcg.
Penicillin	0.5 unit	1.0 unit	10 units
Bacitracin	2.0 units	10.0 units	20 units

*The sulfamylon hydrochloride powder was supplied by the Medical Research Department of Winthrop-Stearns, Inc.

†The antibiotic disks are now available from Difco Laboratories.

The concentrations employed were such that if zones of inhibition were produced around disks A, B and C for a given agent the test organism was sensitive. Inhibition zones around disks B and C and not around A indicated slight or questionable sensitivity. A resistant organism was indicated when no inhibition occurred or when inhibition was produced around only the C disk.

COMPARATIVE SENSITIVITY TESTS.

Each of three plates of asparagin agar was inoculated with an 18- to 20-hour broth culture of the *Pseudomonas* organism. A sterile, cotton-tipped swab was used to spread a drop of the culture (1:1,000 dilution) over the medium.

When the inoculation was completed the antibiotic and sulfamylon disks were placed on the surface of the medium in a

definite arrangement. The disks were so spaced that a zone of inhibition could be easily noted and measured. The pattern permitted testing of all seven agents within a group concentration on a single plate (see Fig. 1).

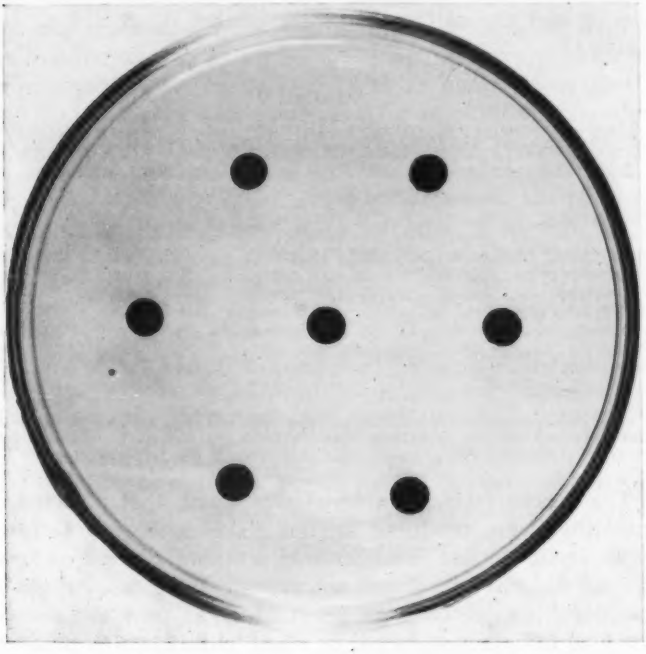

Fig. 1. Pattern used for spacing of antibiotic and sulfamylon disks on the culture media plates inoculated with either pseudomonas aeruginosa or material from an infected ear. Photograph by: U. S. A. F. School of Aviation Medicine.

The use of this pattern required three plates, one for each of the three concentrations A, B and C (see Table 1) to make a comparison of all agents under study. The inoculated plate was placed over the pattern, and with flamed forceps the disks were removed from their containers and placed on the inoculated surface according to the pattern (see Fig. 1). This was done for concentration groups A, B and C for all isolations

of *Pseudomonas* under study. The plates were examined after incubation for 18 to 24 hours at 37° C. The zones of inhibition were easily defined as clear zones surrounded by growth of blue-green pigmented colonies on the asparagin medium and as nonhemolyzed zones surrounded by partially hemolyzed areas when blood agar medium was used. The appearance of the test plates at the end of 18 hours' incubation indicated that sensitivity could be determined in even less time. Culture plates with *P. aeruginosa* growth and showing the typical zones of inhibition present after 18 hours' incubation are presented in Figs. 2, 3 and 4.

Studies were made to determine the time required before an adequate sensitivity reading could be made. This was done

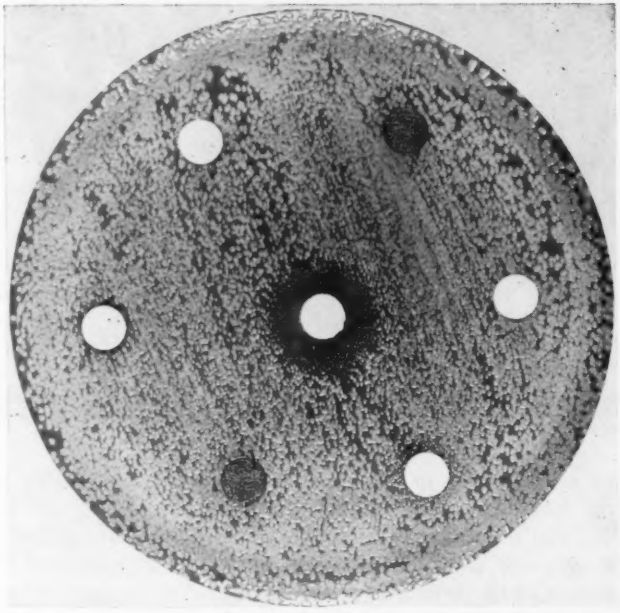

Fig. 2. Inhibition zone produced around the sulfamylon disk only. Pseudomonas aeruginosa sensitive only to sulfamylon. Photograph by: U. S. A. F. School of Aviation Medicine.

by using a motion picture camera, equipped with a timing device which permitted the taking of a picture each minute throughout an incubation period of 18 hours. Within 6 to 8 hours, growth was sufficient to determine the sensitivity of the *P. aeruginosa*.

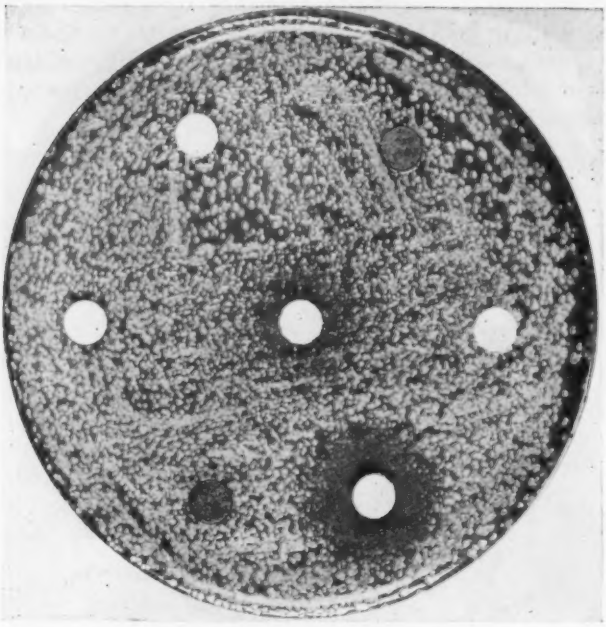

Fig. 3. Inhibition zone produced around the chloromycetin disk only. Pseudomonas aeruginosa culture sensitive only to chloromycetin. Photograph by: U. S. A. F. School of Aviation Medicine.

The effectiveness of this procedure was further tested by taking specimens of the microorganisms directly from the patient and planting them on the primary isolation plates of blood agar and asparagin agar media. By this procedure the sensitivity of the organism was determined in the period usually required for growth of colonies for isolation purposes. This procedure for the isolation and sensitivity testing of

microorganisms is now used routinely for all specimens submitted to this laboratory for bacteriological analyses. A preliminary or tentative report as to antibiotic sensitivity and identity of the etiologic agent can now be made to the physician much sooner than before.

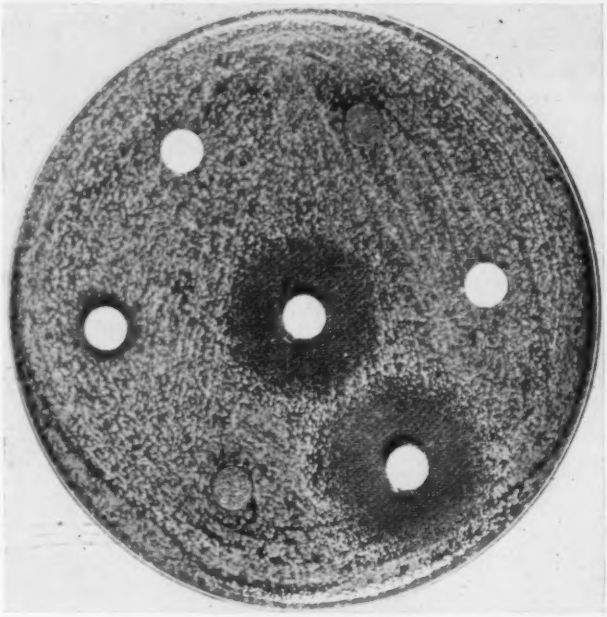

Fig. 4. Inhibition zones produced around the sulfamylon and chloromycetin disks. Pseudomonas aeruginosa culture sensitive to both sulfamylon and chloromycetin. Photograph by: U. S. A. F. School of Aviation Medicine.

RESULTS.

Cultures of *P. aeruginosa* were tested for sensitivity to three different concentrations of each of seven different agents. The results are presented in Table 2.

All of the 54 isolations of *P. aeruginosa* studied were susceptible to either sulfamylon and/or chloromycetin. Among the 52 isolations found sensitive to sulfamylon, six reacted

TABLE 2.

RELATIVE SENSITIVITY OF PSEUDOMONAS AERUGINOSA TO DIFFERENT THERAPEUTIC AGENTS.

Test Agent	Concentration Groups in Which Inhibition Zones Were Produced		
	A	B	C
Sulfamylon	52	54	54
Chloromycetin	45	54	54
Terramycin	19	54	54
Dihydrostreptomycin	2	2	48
Streptomycin	0	2	47
Penicillin	0	0	0
Bacitracin	0	0	0

only to this agent and to none of the others tested. These six cultures were isolated from four different patients. Only one culture reacted to chloromycetin alone. Terramycin was the only additional antibiotic to indicate usefulness as an agent active against this organism. Dihydrostreptomycin and streptomycin showed a poor degree of activity in comparison with that shown by sulfamylon, chloromycetin, and terramycin. Penicillin and bacitracin were not effective in the concentrations employed. *P. aeruginosa* cultures tested with aureomycin sensitivity disks showed no reaction or, at the most, only a slight reaction. Aureomycin, therefore, proved even less effective than streptomycin.

DISCUSSION.

This method of determining the sensitivity of *P. aeruginosa* to various therapeutic agents can more quickly aid the physician in his choice of therapy. The determination was even more rapid when the disks were used on the primary media plates inoculated with infected material taken directly from the patient. When *P. aeruginosa* was the etiologic agent involved, a preliminary report as to the effectiveness of certain antibiotics could usually be made to the physician within eight to 10 hours after fresh culture material was submitted to the laboratory.

SUMMARY.

Determinations were made of the sulfamylon (p-aminomethylbenzene-sulfonamide) and antibiotic sensitivities of 54 cultures of *P. aeruginosa* isolated from cases of otitis externa. Filter paper disks impregnated with suitable concentrations of sulfamylon and the antibiotics were placed on the surface of agar plates inoculated with *P. aeruginosa*. These plates were incubated at 37° C. and examined at intervals for growth inhibition around the various disks. Stop-motion photography of these plates revealed that sufficient growth of *P. aeruginosa* occurred within 6 to 8 hours to indicate well defined zones of growth inhibition around those disks to which the organism was sensitive. A procedure is described for the rapid determination of the sulfamylon and antibiotic sensitivity of *P. aeruginosa* and other microorganisms present in a specimen submitted to the laboratory for bacteriological analysis.

REFERENCES.

1. Beach, E. W., and Hamilton, L. L.: Tropical Otitis Externa. *U. S. Nav. Med. Bull.*, 44:599-602, Mar., 1945.

2. Clark, W. B.: Local Use of Sulfamylon (p-aminomethylbenzene-sulfonamide hydrochloride). *Arch. Ophth.*, 38:682-683, Nov., 1947.

3. Conley, J. J.: Evaluation of Fungous Disease of the External Auditory Canal. *Arch. Otolaryngol.*, 47:721-745, June, 1948.

4. Fox, S. L.: The Use of Sulfamylon in Rhinosinusitis. *Ann. Otol., Rhinol. and Laryngol.*, 56:946-952, Dec., 1947.

5. McLaurin, J. W.: The Local Application of Sulfamylon in Otitis Externa and Chronic Otitis Media. The Laryngoscope, 58:1201-1205, Nov., 1948.

6. Pichotka, Josef, and Lewis, R. B.: Prevention of Secondary Infection Due to Pseudomonas Aeruginosa in Frostbitten Tissue. *Proc. Soc. Exp. Biol. and Med.*, 72:127-130, Oct., 1949.

7. Salven, S. B., and Lewis, M. L.: External Otitis with Additional Studies on the Genus Pseudomonas. *Jour. Bact.*, 51:495-506, Apr., 1946.

8. Bergey's Manual of Determinative Bacteriology. 6th Ed. Baltimore, Md.: Williams and Wilkins Co., 1948.

9. Bacto Sensitivity Disks, Difco Laboratories, Detroit 1, Mich., 1951.

SOCIALIZED MEDICINE.*

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When the invitation was issued to discuss the subject of socialized medicine, I was a bit disturbed because it is a tremendous subject. It seemed, however, that there was no need to go into details concerning its disadvantages from the medical standpoint. You are aware of what has occurred on the Continent, in England and New Zealand under programs of socialized medicine. There has been some confusion concerning what actually constitutes socialized medicine. It is my opinion that any program of medical care for a large portion of our population which is tax supported and governmentally controlled is socialized medicine. The advocates of such programs, from President Truman on down, have made a strenuous effort to avoid the term. Restricted and artificial definitions and adroit terminology, however, have provided them no escape. A recently elected United States Senator stated that there was no magic in words and that any governmental program for medical care was socialized medicine regardless of what it is called.

American medicine faced a great threat to its freedom as the result of President Truman's re-election in November, 1948. He had disregarded the pronouncement of his party and campaigned on a personal platform, promising socialized medicine among many other items. The advocates of such schemes and many of the commentators and columnists believed that his re-election was a "mandate" to enact such legislation.

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The American Medical Association House of Delegates met in St. Louis about one month after the election. It issued a ringing statement of principles, directed a campaign against socialized medicine and levied a $25.00 assessment upon the membership to finance that campaign. The campaign was begun in the Spring of 1949, and the situation less than two years later has undegone tremendous change.

The campaign was designed to convince the people of this country of the harm to their medical care which would result from socialized medicine, to show them the disadvantages of loss of freedom in securing medical care and the hazard to other aspects of their freedom involved in the prospect of wider socialization. At the same time, an effort was made to educate the public to the advantages of voluntary health insurance as a mechanism of spreading the cost of illness.

The response of the medical profession throughout the country was encouraging, although not all that was hoped for. Most of the state and county medical societies participated vigorously and effectively in the campaign, but far too many individual physicians did not. Many of our outstanding physicians, who would be adversely affected by any program of socialized medicine, seemed apathetic to the campaign. This was a problem at the outset and still remains a major problem.

There is considerable overlapping between the groups who attend purely scientific meetings and those who take an interest in the affairs of medical organization. On the other hand, many who are prominent in scientific activities lack interest in protection of the freedom essential to maintenance of high scientific standards. There is far too much of an attitude of letting the other fellow do it.

The preservation of freedom in medicine, as preservation of freedom in general, is the job of everyone. Unless there is much wider participation in this effort, the hazard will not be permanently overcome.

There are certain left wing groups and others who actually favor socialized medicine. Some of these have undergone a

change of heart but some still remain openly antagonistic to the campaign of the Association. Probably nothing can be done to change their minds, and it probably would be a waste of time to try. They are numerically unimportant, even though some of them are quite vocal. Some of them have become less vocal as the cause has lost popularity.

The presence of such people in the profession makes it even more essential that we have an otherwise unified, militant and vigorous profession.

The results of the present campaign can be seen in the change in the character of news stories and the articles in our various periodicals. Formerly, the great bulk were opposed to our point of view, but now the majority are favorable. Over 90 per cent of the newspapers of the country are editorially on record against socialized medicine. About 11,000 organizations of national, state and local scope have passed resolutions against compulsory health insurance. Certain public opinion polls show very favorable trends away from the belief that socialized medicine is either necessary or desirable.

The active controversy between the socializers and the American Medical Association has stimulated great interest in matters of medical care. The growth of voluntary health insurance has been tremendous. In fact, it is still so rapid that by the time the figures are compiled, they are already out of date. At the present time about 20,000,000 people have Blue Shield or other medically sponsored coverage, 40,000,000 are enrolled in Blue Cross, and over 72,000,000 have coverage of some type against the cost of illness. By the end of this year, the number should be more than 80,000,000, and I believe we can confidently look forward to the enrollment of the vast majority of our population within the next few years.

The controversy also has established the hazard of creeping socialism in the minds of many of our people. More and more people see the threat to their own future freedom of activity and endeavor which the socialization of any segment of private enterprise carries with it.

The one large segment of our population which we have not been able to reach, at least as far as its higher echelons are concerned, is organized labor. Even here, there are some encouraging signs.

In December, Mr. William L. Hutcheson, President of the International Carpenters Union, which has 700,000 members, presented a paper entitled, "Socialized Medicine Is No Bargain," to the American Medical Association meeting in Cleveland. Some of you may have seen this paper and it will be distributed ultimately to all the physicians in the country. Within the next year we should see rather marked change on the part of certain other labor leaders.

I have talked with some who are not in the highest positions but yet are of importance who recognize clearly that socialization of medicine would ultimately destroy the freedom of labor. This point of view seems to be growing. It is, therefore, important for physicians to utilize the opportunity to talk to their patients who are members of labor unions, and particularly officers of labor unions, and to emphasize this danger to them. If enough labor union members and officials become convinced of the threat to labor, the official attitude of labor will change and the one large segment of the population which has been vigorously opposing us will cease its activity in behalf of socialized medicine.

The recent elections indicate a strong trend away from socialized medicine. In the larger states, it is difficult to interpret the effect of single issues. The importance of the political activity of physicians as individuals and in informal groups has been apparent in certain close elections and in the elections in certain of the smaller states and in congressional districts. Very few candidates who openly espoused socialized medicine survived the last election. When a candidate espouses socialized medicine, he usually advocates other causes of similar orientation; therefore, the last election probably indicated a trend away from socialistic proposals in general.

Certain important candidates felt it advisable to disavow socialized medicine completely. Some made the effort to escape

by claiming that the administration's plan was not socialized medicine, but others repudiated compulsory health insurance by name.

Senator Pepper, of Florida, in a radio interview attributed his defeat to the activity of the medical profession during the primary election. I have been informed that Senator Graham, of North Carolina, and Senator Taylor, of Idaho, likewise attributed their primary defeats to the activities of the medical profession. Senator Thomas, of Utah, was the author of the administration's omnibus bill for socialized medicine in the 81st Congress. He has attributed his defeat to that fact.

In Milwaukee, Andrew Biemiller, who was the most vigorous and vicious assailant of American medicine in Congress, and had announced that he was the spokesman for the administration's measure, was beaten largely on the issue of socialized medicine. The physicians in Milwaukee did a tremendous job in accomplishing his defeat. The same can be said of Mr. Sullivan, of Omaha.

One of the other lessons to be learned from the last election comes from Ohio. Senator Taft had the full force of the administration, the American Federation of Labor, the Congress of Industrial Organizations, the United Mine Workers and the Railroad Brotherhoods arrayed against him. Their campaign was particularly violent and used comic strips and scurrilous material to discredit Mr. Taft. He carried 84 out of 88 counties, and every industrial area in Ohio.

This clearly showed that the American working man is an intelligent individual who will make up his own mind when the facts are presented to him. Certainly, Mr. Taft did not attain majorities in the industrial areas of Ohio because he received the votes of business men and employers. It was the laboring people of Ohio who demonstrated that they could not be led into blindly following the exhortations of the labor union officials. Neither labor nor any other group can be so influenced.

When the individual citizen is alone with his conscience in the polling booth, he votes upon the basis of his convictions

and not according to the dictates of his leaders. This, I believe, emphasizes the need for greater activity on the part of the profession in general to convince the individual citizen of the dangers of socialized medicine.

As the result of the crystallization of public sentiment against socialized medicine, the administration supporters in the 81st Congress recognized that no legislation of this type could be passed during that Congress. They, therefore, decided to center their attack upon the so-called "fringe bills." The two major ones of these were Federal Aid to Medical Education and Federal Aid to Public Health Departments.

The attitude of the American Medical Association with reference to both of these proposals has been grossly misinterpreted. Our opponents have said that we have resorted to restrictive measures to limit the number of physicians in this country and that we are opposed to Public Health. You, of course, know that nothing could be further from the truth.

The country could use some additional physicians, and we would like to see the number increased, but only if the current high standards of medical education are continued. To lower them would be ruinous to the future of medical care.

There are only a few methods of increasing the number of physicians. We could resort to an accelerated program such as that which was in effect during World War II, but most of us who had experience teaching under that program hope never to see it reinstituted. The faculties became fatigued and did not do as good a job of teaching as they should have done, but more important is that the progressive fatigue of the students made it difficult for them to absorb what was presented to them. I observed this with my own students and feel that we should not resort to such a program again.

We can build new medical schools, but this takes a great deal of time. In one instance, the appropriations for a new school were made almost 10 years ago, and as yet no students have been enrolled. Where concentration of population makes medical schools feasible and they can be adequately supported, they will develop in the course of time.

Some of the two-year schools could expand their curricula to complete the course of medical education, but some are in areas where clinical material would not be available. The medical curriculum could be shortened, as was done in Germany during the war, but this again would reduce the quality of medical education.

The enrollments of our medical schools have been materially increased, but there is a limit to the increases which may be undertaken without sacrifice of quality of education. The individual school must make the decision as to how great an expansion it may undertake without destroying its teaching program.

Some of our medical schools are in financial distress. The American Medical Association recognized this fact and voted a half million dollars to stimulate realistic private support for our medical schools. It was necessary to establish a foundation to receive these funds and money which has been contributed by other organizations and individuals. This fund will be merged in the future with a fund for medical education which is now in the process of formation but is not ready to be announced.

It is our belief that a large enough sum can be raised to augment the present income of the medical schools to the point that their difficulties in carrying out their teaching programs can be relieved. In addition, it is likely that the American Medical Association will support one-time federal grants for remodeling and construction under a program similar to the Hill-Burton Bill for the construction of hospitals.

In this way, need for federal support for continuing operation of our medical schools can be avoided. There is great danger of federal control if subsidies for operation are permitted.

Subsidies bear a certain resemblance to narcotic drugs. They produce an illusory sense of well-being, they make addicts of the recipients and the withdrawal symptoms are horrible. The mere threat of withdrawal of funds would com-

pel compliance to the wishes of the bureaucrats in Washington in most instances. Even if those responsible for running our medical schools were of sufficiently rugged character to refuse to comply with the wishes of the bureaucrats, they would face another source of pressure.

In 1942, in reference to one of the farm programs, the Supreme Court handed down a decision in which Mr. Justice Jackson said, "It is not lack of due process that the government may regulate that which it subsidizes."

While this decision did not concern education or medical education, the principle of law that the Federal Government may regulate that which it subsidizes is clearly established and stands unreversed. The ominous nature of this decision is readily apparent.

We must, therefore, continue to oppose subsidization of medical education and rely upon private support upon a wide base. I hope that every physician in the country will contribute generously and promptly to aid our medical schools.

The situation with reference to subsidization of local public health units is somewhat similar. As the legislation has been drafted, it would place dictatorial powers in the hands of the United States Public Health Service and permit it to direct local public health activities. We believe that the autonomy of local public health officials should be preserved.

The American Medical Association has advocated a Department of Health, headed by a physician with Cabinet status, since 1873. The Association and its members were mainly responsible for the development of public health activities in the United States. The American Medical Association has continuously supported the public health movement ever since.

It is our opinion that public health is primarily a local problem, secondarily a state problem, and that the Federal Government should interest itself in local public health matters only when the local unit of government and the state government have fallen down. We further believe that any subsidy to local public health activities should be to educate the

community which does not have such a program to its value. Subsidies should be for limited periods of time with the expectation that the local unit of government would then support its own public health program. If it did not see fit to do so at the end of a brief period of years, federal support should be withdrawn.

At the present time, we face a grave international situation. There will be many proposals for medical care under the guise of wartime emergency. Some of these may be legitimate projects, but there is great danger that some variety of socialization of medicine will be introduced by executive action or as a portion of some bill which otherwise is a legitimate measure in preparation for war.

We must be continuously alert to see that the present emergency is not perverted into legislation or executive action which will accomplish socialized medicine by oblique methods. One such proposal was included in the War Man Power Act but was eliminated after the opposition of American Medicine had been expressed.

We must not permit the fallacious arguments of alleged lack of patriotism or hindering the war effort to prevail and destroy our liberty while we are presumably engaged in defending it.

On the subject of socialized medicine, the 82nd Congress is more sympathetic to our point of view than was the 81st, and temporarily there is no hazard of direct, honest legislation to accomplish compulsory health insurance. This situation, however, may only be temporary if we do not maintain the activity to prevent it.

We have come a long way in the past two years, but this advance will go for naught if we do not remain vigilant and vigorous. We cannot relax in our effort to convince the people of the hazards of socialized medicine and of socialism in general. We cannot relax in our political activities as individuals and in informal groups until these issues have been thoroughly resolved.

We know the great disadvantages of socialized medicine, and we know the harm of socialism in general; also, one cannot envision an island of medical freedom as standing long in a sea of socialism.

We have a great responsibility to the American people, to ourselves and to our successors to see that these things do not come to pass.

AMERICAN OTOLOGICAL SOCIETY, INC., AWARD OF MERIT.

For their joint research contributing to the knowledge of "The Embryology in Anatomy of the Temporal Bone and the Ear" medals were awarded to Barry G. Anson, Ph.D., Professor of Anatomy, Northwestern School of Medicine, Chicago, Ill., and Theodore Bast, Ph.D., Professor of Anatomy, Wisconsin School of Medicine, Madison, Wis.

The Award of Merit medal is accompanied by an honorarium and is granted by the American Otological Society, Inc., for the purpose of recognizing outstanding service in research in otology and in the interest of encouraging research in the problems of impaired hearing.

TRACHEOTOMY IN BULBAR POLIOMYELITIS.*

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In recent years there has been an increased incidence of poliomyelitis. Adults have been afflicted in greater relative numbers than in the past, and there have been more bulbar cases reported than ever before. Tracheotomy has been used with excellent results. Although Wilson[1] first used tracheotomy for bulbar poliomyelitis in 1932, it was largely the reports of Galloway[2] and Priest, Boies and Goltz[3] that made tracheotomy become a well recognized and in many places an accepted procedure. A review of the literature failed to reveal a paper which correlated the physiopathology of the disease to the clinical course and therapy and discussed the mechanical armamentarium available.

In the Summer and Fall of 1950, in Syracuse, N. Y., there were 334 cases of poliomyelitis. Sixty-eight were bulbar. Twenty cases were severe with pharyngeal obstruction. Six tracheotomies were done. A 73-bed communicable disease hospital was used during the epidemic for the treatment of these cases. Every bulbar or suspected bulbar case received an ear, nose and throat consultation on admission. This was a precedent established that year by the combined attending staff.

In order that the laryngological consultant may be of more value to the patient and to the other services, he should be cognizant of the neuroanatomy and neurophysiology of the disease. The nuclei of the IXth and Xth cranial nerves which control the act of deglutition lie in the region of the medulla and adjacent fourth ventricle. They are the dorsal nucleus of the vagus and the nucleus ambiguous with the tractus soli-

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tarius intervening. The afferent nerve fibres from the pharyngeal plexus run to these nuclei. The circulatory center lies in or near the dorsal nucleus of the vagus, and the respiratory centers are scattered in two more or less distinct groups in the upper part of the pons. If it can be postulated that the portal of entry of the virus is via the afferents of the pharyngeal plexus, all of the above named structures are likely to be affected. Extension to adjacent structures, cervical cord below and upper cranial nuclei, hypothalamus, respiratory and circulatory centers above, would seem likely. The clinical course of the disease appears to follow such a process.[4]

The physiopathology of bulbar poliomyelitis demonstrates four derangements of function:

1. Dysphagia.

2. Involvement of the circulatory or respiratory centers.

3. Paresis or paralysis of the respiratory muscles.

4. Encephalitis or spinal involvement.

The usual course of the disease with its prodromal stage of fever, anorexia and malaise, followed by a temporary respite, recurring in three or four days with the ominous onset of meningismus is well known to all. Nasal voice and nasal regurgitation may then appear, followed by dysphagia. Thoracic and high cervical cord involvement may follow, manifested by weakness of the intercostals, diaphragms and limbs. Occasionally, however, the course may be one of spinal onset with a more or less rapid ascent to involve the bulb. These latter cases are usually much sicker and the prognosis worse than in those beginning as purely bulbar cases.

One of the most important clinical aspects of bulbar poliomyelitis is dysphagia. The swallowing mechanism is a complicated process requiring coordination of several central nuclei and the various muscle groups they control.[5] Edema, toxicity or disease may interfere not only with these nuclei but also with the association pathways between them.

Sjöberg,[6] of Stockholm, Sweden, emphasized two important clinical signs. First, patients with unilateral pharyngeal paralysis swallow best when lying on the healthy side. This he calls the *signe de rideau*. Barium swallow in vagotomized cats shows flaccid, wide pyriform sinuses filled with contrast medium. There is also noted a strong sympatheticotonic contracture of the cricopharyngeus muscle, an atonic dilated esophagus and spasm of the cardiac pinchcock. Esophograms of patients suffering with pharyngeal involvement demonstrate these findings. Bilateral laryngeal abductor paralysis often follows. Thus, the *signe de rideau* may forewarn trouble. Second, with paralysis of the anterior neck muscles, the sternothyroid, sternohyoid, omohyoid and scaleni, innervated by cervical segments one and two, it is clinically evident that the angle between the neck and the chin is much more acute. This is due to the contracture or tonus excess of the antagonists, the mylohyoid, digastric and stylohyoid innervated by the Vth and VIIth cranial nerves with the result that the hyoid bone and larynx are pulled upwards and backwards to the posterior pharyngeal wall blocking the hypopharyngeal airway. This *"angle sign"* is a clinically important warning that anoxia may be imminent. Involvement of the XIth nerve with paralysis of the sternocleidomastoid and trapezius muscles causes the neck to drop backwards and the shoulders forwards with the result that the cervical vertebrae are pushed forward, further occluding the airway. The danger of placing a tight respirator cuff around the neck of such a patient is obvious.

Normally there is about 1,000 to 1,500 cc. of saliva secreted daily, which may be increased to 2,000 by nervous disease, nausea or irritation.[7] Paralysis of the muscles of the tongue, palate and pharynx makes the second stage of deglutition impossible. This relatively tremendous amount of fluid must then pool at the most dependent portion of the patient's upper airway, depending upon his position. The battle the patient has between his desire for air and his effort to rid his airway of secretion not only tires and frightens him but also irritates his throat, increases the amount of secretion, may nauseate

him or cause him to vomit. Vomiting may also be produced by interference with normal esophageal peristalsis due to direct involvement or irritation of the central nuclei.

This secretion may act as a foreign body to the larynx and cause a partial or recurrent spasm of the cords.[8] The larynx may not be able to cope with this situation, and aspiration of the pharyngeal secretions is the result. Rarely there may be anesthesia of the larynx due to involvement of the superior laryngeal nerves. If this is the case, there is no "watchdog of the trachea," and the glottis is a functionally open door to pharyngeal secretions. A paralysis of one cord is uncommon and a bilateral abductor paralysis is relatively rare.

Dysphagia itself does little harm; however, secondary to it are respiratory obstruction and tracheal contamination with resultant anoxia and hypercapnia.[9] Secretional obstruction of the airway causes an increased intrathoracic pressure and has a cupping effect on the capillaries whose walls are already more permeable because of anoxia. This leads to congestion, stasis, edema, exudation, hemorrhage and even plugs with secondary atelectasis and infection. Grave effects of the disease previously thought to be due to the direct action of the virus on the central nervous system, dyspnea, restlessness, antagonism, euphoria, mental depression, disorientation, drowziness, coma, increased blood pressure with later fall, vasomotor failure and circulatory collapse, are now known to be due to secretional obstruction and anoxia. Of all tissue, brain tissue is least able to withstand anoxia. Sixty seconds of anoxia produces distinct morphologic changes in the brain. Three to eight minutes produces widespread damage and necrosis of brain cells or death. Repeated periods of hypoxia may have an accumulative effect. Brain cells previously damaged by anoxia or infection are more susceptible to further damage by anoxia. Edema, hemorrhage or cell necrosis due to virus infection may block oxygen absorption. Profound and lasting effects of even brief periods of anoxia may lead to permanent mental and emotional change, imbecility, insanity, athetoid, Parkinsonian and even decerebrate states.

Because of the danger of even a small degree of anoxia and hypercapnia to a brain and cord already damaged by a viral infection, efforts have been made to correlate the level of the blood oxygen and carbon dioxide to the patient's symptoms and clinical course. Oxygen levels from blood samples are too difficult to determine either accurately or repeatedly. Carbon dioxide combining power is a more applicable clinical test. A photoelectric oximeter attached to the ear lobe of a patient is reasonably accurate and determinations may be repeated at will. According to Gray and Seivers,[10] the narcotic properties of carbon dioxide are directly measureable. Concentrations of less than 10 per cent carbon dioxide of inspired air are not accompanied by symptoms. Those above 30 per cent will produce narcosis in most animals and above 40 per cent, pulmonary edema and hemorrhages from exposed mucous membrane surfaces. During the last war the air force demonstrated that a simple anoxemia of less than 60 per cent arterial oxygen saturation produced unconsciousness without symptoms. The restlessness, apprehension, distress and disorientation seen in asphyxia was thought probably to be due more to hypercapnia than to simple lack of oxygen. Gray also points out that acidosis may be a complication of asphyxia because of the retention of carbon dioxide and the excessive production of lactic acid in the muscles during anoxemia. Two interesting facts were found from these studies: first, that clinical signs of oxygen deficiency are evident only when anoxemia is far advanced; second, even with a normal blood oxygen level, a high blood carbon dioxide level has deleterious effects. Maintenance of a normal oxygen saturation of the blood by artificial means is, therefore, not enough. The airway has to be open to rid the blood stream of excess carbon dioxide.

Weakness or paralysis of one or both diaphragms due to high cervical cord involvement and ineffectual chest expansion due to thoracic involvement is so often associated with disturbance of the pharynx and larynx that they must be considered as part of the clinical picture of bulbar poliomyelitis even though they are not due to interference with the bulb

itself. Weak, ineffectual cough, retention of aspirated material, and atelectasis complicated by infection may result.

For the sake of completeness, respiratory and circulatory center involvement is included. Baker[11] states that of 183 bulbar poliomyelitis patients, 36 were classified as belonging to the respiratory center group. Of these, 69.1 per cent died. Twelve were classified in the circulatory center group, and 83 per cent of these succumbed. Involvement of the respiratory center is indicated by irregularities of the rhythm and depth of respiration even though the intercostal muscles and diaphragms are functioning normally. Apprehension, confusion and delirium leading to coma gradually develop, accompanied by periods of apnea and Cheyne-Stokes respiration. Cyanosis becomes increasingly intense. In the bulbar circulatory group, patients have a dusky, red, flushed, florid appearance; the lips are a deep cherry red; the pulse becomes rapid, and the blood pressure has a downward trend; the patients are restless, anxious, apprehensive and at times confused, and fever is high.

Encephalitic symptoms, hyperexcitability, restlessness, irritability, mental confusion, irrationality, personality disturbance, insomnia or somnolence are frequent; however, most of these cerebral symptoms disappear on adequate oxygen administration and a clear airway. It would seem likely, therefore, that most cases previously classified as encephalitic in reality may be only anoxic.

Treatment: The therapeutic objective is a free and normal gaseous interchange in the pulmonary alveoli. To recapitulate: hypopharyngeal pooling of secretions due to involvement of IXth and Xth cranial nerves accompanied by weakness or paralysis of the intercostals and diaphragms is the chief factor with which we have to deal. Associated with and secondary to this are anoxia, dehydration, infection and fear.

The reasons for the accumulation, pooling and tracheal contamination of secretions have been discussed, and the complications resulting from these have been listed. The patient

who can still swallow should be placed in the position easiest for him, while those who cannot should be placed in Trendelenberg position sufficient to clear the hypopharynx of secretions. Prone position with the head to one side takes care of the situation fairly well when this position is practicable. In the supine Trendelenberg position secretion will pool in the nasopharynx where it may be removed by intranasal suction. Aspiration should be done gently as it is irritating and may cause an increased amount of secretion or nausea. A word of warning should be given. Water suction has been known to back up and drown a patient.

Fluid intake should be somewhat low to keep secretions at a minimum but not low enough to cause dehydration. Atropine should not be used for obvious reasons. Food and fluids cannot be given by mouth. Two methods, parenteral and tube feeding, are then available. During the very acute stage of the disease, which as a rule lasts only a few days, intravenous fluids are the method of choice. Saline and glucose suffice in most cases; however, intravenous aminoacids or even plasma or blood may be indicated occasionally. Tube feeding has been frowned upon because of irritation which may cause increased secretion and vomiting. The tube should be passed into the stomach to lessen the possibility of regurgitation because of the atony of the esophagus and the spasm of the cardia. The paralysis of the swallowing mechanism, the flaccidity of the pharyngeal musculature, the spasm of the cricopharyngeus and cardia, and the atony of the esophagus may make passing the tube very difficult indeed. It may, however, be passed with the aid of a laryngoscope and forceps, an esophagoscope or esophageal speculum, on a stylette, or with the eye of the tube fitted into a fine flexible-tipped esophageal bougie. The new polythene plastic Levine tubes are less irritating then the rubber tubes. I have found, however, that polythene tubing, the lumen of which is large enough to admit only a No. 20 gauge needle, was tolerated very nicely by both child and adult patients without any irritation, discomfort, nausea or vomiting, and that a continuous slow drip could be attached to this tubing which would give the patient an adequate

feeding. It is of much assistance in maintaining adequate nutrition and hydration without irritation, discomfort or nausea. This tubing is illustrated in use in the accompanying photographs (see Figs. 1 and 2).

If secretions are aspirated into the tracheobronchial tree before or despite the preceding measures, the lower airway will become obstructed by secretion and atelectasis, and infection will take place. The trachea of a patient lying supine is directly posteriorly at an angle of 20 degrees; therefore, at

Fig. 1. Three-year-old tracheotomized child in tank type respirator. Small plastic feeding tube, Monahan positive pressure apparatus, and Spira-twist plastic neck cuff illustrated in use.

least 30 degrees of Trendelenberg position is necessary for adequate postural drainage. This amount is extremely difficult as the patient must be literally suspended by his ankles to prevent sliding up the bed. It is nearly impossible in a respirator. The cilia of the mucosa of the tracheobronchial tree will function much better if aided by gravity. Coughing should be encouraged. Intranasal tracheal aspiration is the easiest and least traumatic method of ridding the lower airway of

secretions. It may be repeated often with little danger or discomfort to the patient. If this is not possible, direct laryngoscopy to pass the catheter may be used. Direct laryngoscopy also allows one to look for paralysis of the cords, test for laryngeal anesthesia, and observe how much of the respiratory obstruction is hypopharyngeal. If this seems impractical, due to a great deal of secretion, aspirated vomitus, or

Fig. 2. Composite posed picture of a convalescent tracheotomized 14-year-old girl illustrating use of small plastic feeding tube, plastic bubble chest type respirator, and Respir-aid rocking bed.

atelectasis, one may resort to bronchoscopy. I should like to give a word of warning: an anesthetized larynx is an open door to the tracheobronchial tree; therefore, bronchoscopy

or laryngoscopy should be done without local anesthesia if possible. Another warning: if bronchoscopy is necessary, I have found that laryngeal irritation, stimulation of a great deal of secretion (witness many bronchoscopies in normal patients), and rapid reaccumulation of pulmonary secretions may necessitate early tracheotomy.

Since there is a high incidence of atelectasis, patients should be encouraged to cough at frequent intervals, do deep breathing exercises, exhale through blow bottles or inflate rubber balloons. A face mask is available for the Monahan positive pressure apparatus, of which more will be said later. Through it, alone, or in conjunction with the respirator, room air or oxygen may be delivered at pressures regulated up to 20 mm. of mercury. This device will greatly discourage atelectasis if it seems imminent and will help to re-expand an atelectatic lung and reduce pulmonary edema.

There is an ever present danger of infection due to contamination of the tracheobronchial tree by aspirated pharyngeal secretions. These patients should be placed on prophylactic chemotherapy. Sputum cultures should be obtained as mixed infection is common. Unfortunately an infection with B. pyocyaneus is not rare. This organism is resistant to most therapy but will usually succumb to full and continued doses of streptomycin. Prophylaxis should be continued as long as there is any possibility of primary or recurrent pulmonary infection.

Restlessness, anxiety and fear are common and very real symptoms of bulbar poliomyelitis. Calm, quiet reassurance should take the place of sedatives when possible. Narcotics further depress the cough reflex and respiratory center and are contraindicated in the acute phase of the disease.

The most fundamental problem is getting an adequate amount of oxygen to the alveoli and removing the accumulated carbon dioxide. For this, a clear airway is essential. Supplementary oxygen may be given by face mask, intranasal tube or tent. The mask alone is not tolerated well over a long

period of time. The catheter is better tolerated but may irritate, cause gagging and dry the secretions. The tent is most comfortable but is not as efficient in oxygen concentration. An oxygen-carbon-dioxide mixture may not stimulate respiration as a hypercapnia may already be present. The oxygen should be moistened by being passed through water, to which may be added sodium lauryl sulphate, U. S. P., a wetting agent.

Restlessness, anxiety, fear, air hunger, diminished expansion of the thoracic cage and diaphragmatic movement, increasing pulse and respiratory rate, pallor, and finally cyanosis are indications for artificial respiratory assistance. The simplest and most immediately available method is manual artificial respiration. Hand pumping the bag of an anesthesia machine connected to a tight fitting face mask makes an ideal temporary respirator; however, its most ideal use is during tracheotomy. The patient may be removed from the respirator and the operation done with ease without respiratory embarrassment to the patient or the inconvenience of a tank type respirator to the surgeon.

The tank respirator is universally the most satisfactory and efficient, but has certain disadvantages. Nursing care and administration of intramuscular or intravenous medication is difficult. The psychological effect on the patient may be bad. Lying supine with little chance of change of position and a tight chafing neck cuff is uncomfortable. The major problem, however, comes with tracheotomy when the neck cuff must be kept below the tracheotomy tube. The usual sponge rubber neck cuff is difficult to hold in this position but may be held by a long, thin surgical retractor attached with heavy tape to the top midsection of the respirator.[12] The Spiratwist plastic neck cuff with its readily adjustable lumen has been found eminently satisfactory. A special curved metal rod can be slid in place, holding this cuff easily in position. Tracheotomy care in the respirator is greatly facilitated by this efficient and easily adjustable device. This is illustrated in Fig. 1.

The plastic bubble chest type respirator[13] is much more comfortable, better tolerated by the patient, easier for nursing care, much more convenient in tracheotomized patients but is not as efficient in the more completely paralyzed patients. In mild and convalescent cases, as a temporary expedient, and in transportation its value is great (see Fig. 2).

The McKesson respir-aid rocking bed,[14] an adaptation of the Sanders oscillating bed, used to improve circulation in peripheral vascular disease, works on the principle of passive motion of the diaphragm, caused by shifting the abdominal contents in its up and down motion. The rate may be adjusted from 12 to 26 per minute and the depth of respiration controlled by the angle to which the bed is deviated. The passive motion of the diaphragm may encourage whatever weak phrenic stimuli are available. Frequency of atelectasis is diminished. Muscular tone and circulation are improved. The incidence of deep phlebitis in the lower limbs with secondary pulmonary embolism, a not too uncommon occurrence in these patients, is lessened. Its practical use is about the same as the chest type respirator with the added advantages listed (see Fig. 2).

The electrophrenic respirator developed in Boston may have limited use. The motor point of the phrenic nerve may be found by digital exploration of the angle between the clavicle and the sternocleidomastoid muscle with an electrode mounted on especially equipped rubber finger cot.

When found, contact may be maintained by taping the electrode to the skin in conjunction with external pressure. A metal mesh strap type electrode is available which may be wrapped around a surgically exposed phrenic nerve. The depth and rate of respiratory may be controlled by adjusting the intensity and the time interval between the electric stimuli. This apparatus may have a real place in cases of respiratory center failure.

Tracheotomy: A complete understanding of the pathophysiology of bulbar poliomyelitis should make the indications for

tracheotomy self-evident. They will, however, be listed. Galloway suggests the following indications:

1. Progressive anoxia with secretions in the upper airway.
2. Rapidly progressive bulbar symptoms.
3. Fluid accumulation despite frequent aspiration in a patient who requires a respirator.
4. Pronounced restlessness or stupor in a patient in a respirator even if the paralysis is apparently of the spinal type.
5. Unconsciousness or pronounced restlessness in the patient who does not respond to other treatment in a few moments.
6. Grave signs of vasomotor failure.
7. Bilateral spasm or paralysis of the vocal cords.
8. Untrained or inefficient attendants, inadequate equipment, or poor patient cooperation with doubt that the airway will be kept free from secretions.

The Minnesota Poliomyelitis Research Commission states that "Elective tracheotomy is indicated when recent onset of bulbar symptoms with evidence of progression of illness, progressive difficulty in swallowing or accumulation of secretions in the throat, and mental changes, especially anxiety, apprehension, hyperactivity, confusion or euphoria occur." They further state that "The appearance of laryngeal stridor, dyspnea despite adequate chest expansion, cyanosis and severe encephalitic symptoms indicate serious obstruction of the airway and require emergency tracheotomy." Mechanically forced inspiration through a pool of mucus in the pharynx will draw it into the chest.[15] For this reason the respirator was for many years said to be contraindicated in bulbar poliomyelitis. If, however, tracheotomy is done, the air exchange by-passes this fluid and there is little danger of aspiration.

Little need be said about the technique or complications of the operation. The usual midline incision may, however, be replaced by a transverse incision, making the operation easier

if done in the respirator, causing less chafing of the neck cuff on the wound, and giving more comfort and less residual scar to the patient. Subcutaneous or mediastinal emphysema and pneumothorax have not been reported as complications either with or without the respirator.

As usual in tracheotomy, the after-care is much more important than the surgery. Constant, well directed nursing care of high quality is essential. The secretions in the mouth and nasopharynx should still be removed. The lumen of the tube should not be encroached upon by allowing secretion to dry on it. The tracheobronchial tree should be kept free of secretions by frequent suction. Cough should be encouraged. Since tracheotomy by-passes the moistening effect of the nasal mucosa, the humidity of the room should be kept high to avoid drying of secretions and crusting. The Walton cold steam humidifier is excellent. A few drops of saline or weak sodium bicarbonate solution dropped into the trachea discourages or may loosen crusts. Apprehension and increased pulse may be a warning that there is an obstructing mucus plug or crust which may require bronchoscopic removal. Prophylactic chemotherapy should be given. Oxygen administered directly into the trachea is drying. Moistening and administration through a funnel held over the tracheotomy tube will help to prevent this.

Pulmonary edema, atelectasis or air hunger despite the respirator may be benefited by positive pressure respiration. The Bennett positive pressure apparatus is excellent; it may be used alone or in conjunction with the respirator. Alone, it works on the same principle as hand pumping the bag of an anesthesia machine with a closed system. With the respirator it accomplishes respiration by the regulated and synchronized dual action of negative pressure within the respirator and its own positive pressure which delivers filtered humidified air or oxygen into the tracheotomy tube or face mask. The apparatus is attached to the bellows of the respirator to synchronize their independent action. Simultaneous positive and negative pressure respiration has reduced or eliminated pulmonary acidosis, dried up excessive tracheal

secretions or pulmonary edema, and synchronized the patient's respiratory rhythm when disturbed by excess carbon dioxide accumulation or by a direct action of the virus on the respiratory center (see Fig. 1).

A simpler type of positive pressure may be devised by connecting an oxygen stream directly to the tracheotomy tube.[16] Not only does the pressure in the line tend to expand the lungs on inspiration, but since expiration must be accomplished against this pressure and around the tracheotomy tube through the larynx, the same effect as a blow bottle is achieved. Secretions in the hypopharynx at the same time are forced upward where they may be more readily removed. A similar system employs a special type of tracheotomy tube which has two lateral and one superior opening.[17,18] The superior opening is plugged except when suction is necessary. Positive pressure inspiration comes from a humidified, filtered oxygen source into one lateral opening; positive pressure expiration through the opposite lateral opening to a blow bottle. Either of the last two methods of positive pressure can easily be assembled in any hospital and are very adequate, although more difficult to maintain than the mechanical Bennett positive pressure apparatus.

The problem of when to decanulate a patient may be perplexing and trial and error may be the only solution. In general, however, it is best to wait until the patient is out of the respirator, has no more tracheal secretion, and can breathe comfortably for 48 hours with a regular or fenestrated tracheotomy tube plugged off. It is better to leave the tube in too long than to have to reinsert it through a tracheal stoma that has completely closed its lumen. Needless to say the psychic trauma of the latter is far worse than the former.

CASE REPORTS.

Case 1: G. B., a 34-year-old factory inspector, complained of back pain, fever and stiff neck for three days prior to admission. Upon admission his temperature was 100.4°. There was a fine tremor of the hands, marked nuchal rigidity and back stiffness. Spinal fluid showed 250 cells and 170 mg. per cent of protein. This progressed to quadraplegia with concomitant facial and pharyngeal paralysis. Four days after admission,

he became disoriented and started to pool secretions in his pharynx. He was bronchoscoped and secretions were aspirated, but they rapidly reaccumulated. He was placed in a respirator, but his respirations were asynchronous with the machine. He was removed and a tracheotomy performed with marked improvement of cyanosis and mental changes. His course was later complicated by thrombophlebitis and pulmonary embolism. He was treated with anticoagulants. The patient was decanulated on the twenty-eighth day and is now doing well, although he exhibits extensive residual paralysis.

Case 2: M. R., a 36-year-old Methodist minister, developed headaches, stiff neck, nausea and vomiting for five days prior to admission. Spinal tap at another hospital revealed pleocytosis. When examined he was found to be severely ill with a temperature of 102°. His pharynx was filled with purulent secretion, and there was a right facial weakness and flaccid arms and legs. He required constant suctioning, and within two days he was completely irrational. Because of severe persistent cyanosis, irrationality and confusion, a tracheotomy was performed. The trachea was found to be free from secretions at the time of surgery. It was felt that much of the hypoxia was secondary to prolapse of the tongue occluding the hypopharynx. The cyanosis and mental confusion cleared completely. He did fairly well except that his trachea had to be suctioned almost constantly. In spite of this, his temperature rose to 104°, and he had frequent episodes of cyanosis and air hunger. Positive pressure oxygen was given through the tracheotomy tube with considerable relief of these symptoms. His tracheotomy tube was removed on two occasions but had to be replaced because of recurring secretional obstruction. He was permanently decanulated on the sixty-fifth day. He was gradually removed from the respirator to the rocking bed and then to a regular bed without respiratory difficulty. Both arms and both legs were completely paralyzed. He had residual facial paralysis and some weakness of his pharyngeal musculature. On the one hundred and twenty-first day he became weak, confused, had a little mucus in his throat and died suddenly three days later. Postmortem examination showed his tracheobronchial tree to be clear of secretions and only a tiny patch of atelectasis in the base of the left lung. There was very extensive destruction of the anterior horn cells with actual canulization of the cord.

Case 3: D. C., a seven-year-old white female, had been ill five days with nausea, vomiting, stiff back and nasal regurgitation. Temperature rose to 103°. She spoke with a nasal twang. There was left facial weakness and marked nuchal rigidity, 154 cells and 53 mg. per cent protein in the cerebrospinal fluid. Her restlessness progressively increased. Her respiratory rhythm was not smooth. There was a moderate amount of secretion in the pharynx. Tracheotomy at this time was suggested. It was refused by the attending physician, but six hours later tracheotomy was done because of sudden cyanosis due to bilateral abductor paralysis. The patient went into peripheral shock with Biot breathing and died four hours later.

Case 4: L. B., a three-year-old male, was found to be ill five days before admission when he awoke crying. Three days before admission he was unable to move his arms or legs. Physical examination revealed a temperature of 100°. There was slight flaring of the alae nasae and there was moderate respiratory distress with little chest motion. All four extremities were weak. Spinal tap revealed 130 cells and 48 mg. per cent of protein. On the second hospital day, his respiration became irregular and feeble. He was placed in a respirator and given intranasal oxygen.

The next day he had two convulsions and then became comatose. Direct laryngoscopy revealed a normal larynx without paralysis or edema and very little secretion. Because of a progressive downhill course, a tracheotomy was done. Very little mucus was found in the trachea; however, the patient's color immediately improved, and further course was uneventful. He was decanulated on the fifty-seventh day, and at the present time he uses a rocking bed about half of the time, the rest of the time being in the tank type respirator.

Case 5: M. R., a 14-year-old female, had been vomiting for four days and developed a nasal twang to her voice with marked nasal regurgitation. There were 94 cells and 39 mg. per cent protein in the spinal fluid. Positive physical findings were a temperatuer of 104.5°, blood pressure of 140/90, and much pooling of mucus. She was able to speak only in a whisper. There was only minimal intercostal motion, but she was well oriented. She was suctioned, placed in an oxygen tent and seemed to improve. Because pooling continued and respiration became more irregular with periods of apnea, a tracheotomy was performed. She was placed in a respirator for only 12 hours. Her subsequent course was good with the aid of a rocking bed. The tracheotomy tube was removed 10 days later. She was discharged from the hospital with only a slight nasal voice and no other residual paralysis.

Case 6: J. N., 16-year-old white male, complained of headache, stiff neck, and a weak left leg. Spinal tap at another hospital showed 104 cells with a positive Pandy. He developed weakness of the right arm and leg and some respiratory distress. He was, therefore, transferred to Syracuse. His temperature was 103°. He was apprehensive and had a very weak cough with many coarse rales in the right lung. Two days later he was found to have complete atelectasis of the right middle and lower lobes. He was bronchoscoped, and a fluid level was found just below the right upper lobe orifice. After this secretion was removed sounds could be heard coming through the lower portion of the right lung. Soon, however, there was progressive respiratory difficulty with reaccumulation of secretions. Tracheotomy was done, and a great deal of mucus was found in the tracheobronchial tree. He immediately improved after tracheotomy. A moderate amount of secretion continued and was aspirated. Gradually the amount of these secretions reduced. He was decanulated on the thirteenth day. His subsequent course was uneventful.

Comment: It seemed quite definite that tracheotomy was of great value in these cases. Of these six patients, two died. The first patient died of late complications long after he had been decanulated. It was felt that the second might not have died had an earlier tracheotomy been done. It is my feeling that the other patients would certainly have died had not tracheotomy been done. Of the 68 cases of bulbar poliomyelitis only six died. Two have been mentioned. Three died suddenly without obstruction of the airway, apparently due to involvement of the circulatory center. Another died of a very rapidly progressive bulbar type of disease. Of a total

of 20 cases demonstrating partial obstruction of the airway, tracheotomy was done in only six because of the other measures mentioned and a careful selection of cases.

Summary: The pathophysiology, clinical course, signs, symptoms and complications of bulbar poliomyelitis have been discussed in detail. An attempt has been made to correlate treatment with altered physiology. The therapeutic armamentarium that is available has been described. Indications for tracheotomy have been reviewed, and six cases requiring tracheotomy in the 1950 epidemic in Syracuse, N. Y., have been presented.

Conclusions: The most important symptom of bulbar poliomyelitis is the inability to swallow. Accumulated secretions obstructing the airway and contaminating the tracheal bronchial tree, anoxia and hypercapnia are the result. Tracheotomy, if done before anoxia has produced serious central nervous system damage employed in conjunction with other therapeutic measures, gives the patient the best chance of survival until whatever natural recovery of damaged neural tissue can occur.

BIBLIOGRAPHY.

1. Wilson, J. L.: Acute Anterior Poliomyelitis. *New Eng. Jour. Med.*, 206:887-893, Apr. 21, 1932.

2. Galloway, T. C.: Tracheotomy in Bulbar Poliomyelitis. *Jour. A. M. A.*, 123:1096-1097, Dec. 25, 1943.

3. Priest, R. E.; Boies, L. R., and Goltz, N. F.: Tracheotomy in Bulbar Poliomyelitis. *Ann. Otol., Rhinol. and Laryngol.*, 56:250-263, June, 1947.

4. McIntosh, G. A., and McLeay, D. B.: Poliomyelitis. *Med. Jour. Australia*, 11:661-665, Nov. 5, 1949.

5. Strobel, R. J., and Canfield, N.: Tracheotomy in Poliomyelitis. *Arch. Otolaryngol.*, 52:341-351, Sept., 1950.

6. Sjoberg, A.: Mechanism of Suffocation in Spinobulbar Poliomyelitis and Experiences with Operative Treatment. *Arch. Otolaryngol.*, 52: 323-340, Sept., 1950.

7. Galloway, T. C., and Seifert, M. H.: Bulbar Poliomyelitis *Jour. A. M. A.*, 141:1-8, Sept. 3, 1949.

8. Sutton, H., and Angell, R.: Bulbar Poliomyelitis. *Va. Med. Month.*, 77:216-221, June, 1948.

9. Galloway, T. C.: The Danger of Unrecognized Anoxia in Laryngology. *Ann. Otol., Rhinol. and Laryngol.*, 55:508-513, Sept., 1946.

10. Mitchel, J. R., and Hill, L.: Tracheotomy in Bulbar Poliomyelitis. *Jour. Iowa State Med. Soc.*, Oct., 1950.

11. Stinson, P. M., and Baker, H. B.: Papers and Discussions Presented at the First International Poliomyelitis Conference. J. B. Lippincott, 1949.

12. Allen, R. T., and Landmesser, C. M.: Adjusting the Collar for Tracheotomy in a Patient in a Respirator. *Jour. A. M. A.*, 142:478, Feb. 18, 1950.

13. Peterson, R. L., and Ward, R. C.: Tracheotomy in Poliomyelitis Simplified with New Respirator. *Arch. Otolaryngol.*, 48:156-158, Aug., 1948.

14. Wright, J.: The Respir-Aid Rocking Bed in Poliomyelitis. *Amer. Jour. Nursing*, 47:454-463, July, 1947.

15. McLorinan, H.: The Use of Tracheotomy in Pharyngeal and Respiratory Paralysis Following Diphtheria and Bulbar Poliomyelitis. *Med. Jour. Australia*, 1:765-766, June 19, 1948.

16. Glaser, D. F.: Tracheotomy in Bulbar Poliomyelitis. *Jour. Pediat.*, 27:560-564, Dec., 1945.

17. Kottke, F. J., and Kubicek, W. G.: The Patient with Bulbar Poliomyelitis. *Amer. Jour. Nursing*, 49:374-378, June, 1949.

18. Downing, J. A.: Some Mechanical Tracheotomy Problems in Bulbar Poliomyelitis. *Jour. Iowa State Med. Soc.*, Oct., 1950.

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The 1951-1952 Home Study Courses in the basic sciences related to ophthalmology and otolaryngology, offered as a part of the educational program of the American Academy of Ophthalmology and Otolaryngology, will begin on Sept. 1 and continue for a period of 10 months. Registrations must be completed before Aug. 15. Detailed information and application forms may be secured from Dr. William L. Benedict, the executive secretary-treasurer of the Academy, 100 First Avenue Building, Rochester, Minn.

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE OF THE AMERICAN MEDICAL ASSOCIATION.

June 1, 1951.

Audicon Models 400 and 415.
Manufacturer: National Earphone Co., Inc., 20-22 Shipman St., Newark 2, N. J.

Audivox Model Super 67.
Manufacturer: Audivox, Inc., 259 W. 14th St., New York 11, N. Y.

Aurex Model F and Model H.
Manufacturer: Aurex Corp., 1117 N. Franklin St., Chicago, Ill.

Beltone Harmony Mono-Pac; Beltone Symphonette; Beltone Mono-Pac Model M.
Manufacturer: Beltone Hearing Aid Co., 1450 W. 19th St., Chicago, Ill.

Cleartone Model 500; Cleartone Regency Model.
Manufacturer: American Sound Products, Inc., 2454 S. Michigan Ave., Chicago 16, Ill.

Dahlberg Model D-1.
Manufacturer: The Dahlberg Co., 2730 W. Lake St., Chicago 16, Ill.

Dysonic Model 1.
Manufacturer: Dynamic Hearing Aids, 43 Exchange Pl., New York 5, N. Y.

Electroear Model C.
Manufacturer: American Earphone Co., Inc., 10 East 43rd St., New York 17, N. Y.

Gem Hearing Aid Model V-35; Gem Model V-60.
Manufacturer: Gem Ear Phone Co., Inc., 50 W. 29th St., New York 1, N. Y.

Maico Atomeer; Maico UE-Atomeer; Maico Quiet Ear Models G and H Maico.
Manufacturer: Maico Co., Inc., North Third St., Minneapolis, Minn.

Mears (Crystal and Magnetic) Aurophone Model 200; 1947—Mears Aurophone Model 98.

Manufacturer: Mears Radio Hearing Device Corp., 1 W. 34th St., New York, N. Y.

Micronic Model 101 (Magnetic Receiver); Micronic Model 303; Micronic Star Model. (See Silver Micronic.)

Manufacturer: Micronic Co., 727 Atlantic Ave., Boston 11, Mass.

Microtone T-3 Audiomatic; Microtone T-5 Audiomatic; Microtone Classic Model T9; Microtone Model 45.

Manufacturer: Microtone Co., 4602 Nicollet Ave., Minneapolis 9, Minn.

National Cub Model C; National Standard Model T; National Star Model S; National Ultrathin Model 504; National Vanity Model 506.

Manufacturer: National Hearing Aid Laboratories, 815 S. Hill St., Los Angeles 14, Calif.

Otarion Model E-1S; Otarion Model E-2; Otarion Model E-4; Otarion Models F-1, F-2 and F-3; Otarion Model G-1 (Whisperwate).

Manufacturer: Otarion Hearing Aids, 159 N. Dearborn St., Chicago, Ill.

Paravox Model J (Tiny-Myte); Models VH and VL (Standard); Paravox Model XT (Xtra-Thin); Paravox Model XTS (Xtra-Thin); Paravox Model Y (YM, YC and YC-7) (Veri-Small).

Manufacturer: Paravox, Inc., 2056 E. 4th St., Cleveland, Ohio.

Radioear Permo-Magnetic Multipower; Radioear Permo-Magnetic Uniphone; Radio Ear All Magnetic Model 55; Radioear Model 62 Starlet; Model 72.

Manufacturer: E. A. Myers & Sons, 306 Beverly Rd., Mt. Lebanon, Pittsburgh, Pa.

Rochester Model R-1; Model R-2.

Manufacturer: The Microtone Co., Ford Parkway on the Mississippi, St. Paul 1, Minn.

Silver Micronic; Silver Micronic (Magnetic and Crystal) Models 202M and 202C. (See Micronic.)
Manufacturer: Micronic Corp., 101 Tremont St., Boston 8, Mass.
(See Micronic.)

Silvertone Model 103BM.
Manufacturer: National Hearing Aid Laboratories, 815 S. Hill St., Los Angeles 14, Calif.
Distributor: Sears-Roebuck & Co., 925 S. Homan Ave., Chicago 7, Ill.

Silvertone Model J-92.
Manufacturer: Sears-Roebuck Co., 925 S. Homan Ave., Chicago 7, Ill.

Silvertone Model M-35.
Manufacturer: Micronic Co., 727 Atlantic Ave., Boston 11, Mass.
Distributor: Sears-Roebuck Co., 925 S. Homan Ave., Chicago 7, Ill.

Silvertone Model P-15.
Manufacturer: W. E. Johnston Mfg. Co., 708W. 40th St., Minneapolis, Minn.
Distributor: Sears-Roebuck & Co., 925 S. Homan Ave., Chicago 7, Ill.

Solo-Pak Model 99.
Manufacturer: Solo-Pak Electronics Corp., Linden St., Reading, Mass.

Sonotone Model 600; Sonotone Model 700; Sonotone Model 900; Sonotone Models 910 and 920; Sonotone Model 925; Sonotone Model 940.
Manufacturer: Sonotone Corp., Elmsford, N. Y.

Superfonic Hearing Aid.
Manufacturer: American Sound Products, Inc., 2454 S. Michigan Ave., Chicago, Ill.

Televox Model E.
Manufacturer: Televox Mfg. Co., 117 S. Broad St., Philadelphia 7, Pa.

Telex Model 22; Telex Model 97; Telex Model 99; Telex Model 200; Telex Model 300B; Telex Model 400; Telex Model 1700.
Manufacturer: Telex, Inc., Minneapolis 1, Minn.

Tonamic Model 50.
Manufacturer: Tonamic, Inc., 12 Russell St., Everett 49, Mass.

Tonemaster Model Royal.
Manufacturer: Tonemasters, Inc., 400 S. Washington St., Peoria 2, Ill.

Trimm Vacuum Tube No. 300.
Manufacturer: Trimm, Inc., 400 W. Lake St., Libertyville, Ill.

Unex Model "A"; Unex Midget Model 95; Unex Midget Model 110.
Manufacturer: Nichols & Clark, Hathorne, Mass.

Vacolite Model J.
Manufacturer: Vacolite Co., 3003 N. Henderson St., Dallas 6, Tex.

Western Electric Models 65 and 66.
Manufacturer: Audivox, Inc., successor to Western Electric Hearing Aid Division, 259 W. 14th St., New York 11, N. Y.

Zenith Model 75; Zenith Miniature 75; Zenith Model Royal.
Manufacturer: Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

All of the accepted hearing devices employ vacuum tubes.

Accepted Hearing Aids more than five years old have been omitted from this list for brevity.

TABLE HEARING AIDS.

Aurex (Semi-Portable).
Manufacturer: Aurex Corp., 1117 N. Franklin St., Chicago (10), Ill.

Precision Table Hearing Aid.
Manufacturer: Precision Hearing Aids, 5157 W. Grand Ave., Chicago 39, Ill.

Sonotone Professional Table Set Model 50.
Manufacturer: Sonotone Corp., Elmsford, N. Y.

All of the Accepted hearing devices employ vacuum tubes.

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Meeting: Royal York Hotel, Toronto, Canada, May 20-21, 1952.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President Dr. C. Stewart Nash, 108 Medical Arts Bldg., Rochester, N. Y.
Meeting: Royal York Hotel, Toronto, Canada, May 22-24, 1952.

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AMERICAN BOARD OF OTOLARYNGOLOGY.

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Palmer House, Chicago, Ill., Oct. 9-12, 1951.

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Secretary: Dr. Frasier Williams.
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Place: Army and Navy Club, Washington, D. C.

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Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.
Meeting: Palmer House, Chicago, Ill., Oct. 14-20, 1951.

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OTOSCLEROSIS STUDY GROUP.

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Meeting: Chicago, Ill., Oct. 19, 1951.

PAN AMERICAN ASSOCIATION OF OTO-RHINO-LARYNGOLOGY AND BRONCHO-ESOPHAGOLOGY.

Meeting: Third Pan American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.

Time and Place: Havana, Cuba, January, 1952. Dr. Jose Gros. For information write Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.

SECOND LATIN AMERICAN CONGRESS OF OTORHINOLARYNGOLOGY AND BRONCHOESOPHAGOLOGY.

Time and Place: Sao Paulo, Brazil, July, 1951.

President: Professor A. dePaula Santos.

Secretaries: Dr. Jose de Rezende Barbosa, Dr. Plinio de Mattos Barretto, Hospital das Clinicas, Sao Paulo, Brazil.

AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION.

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Meeting: Royal York Hotel, Toronto, Canada, May 22-24, 1952.

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